JMBFS
Journal of Microbiology, Biotechnology and Food Sciences
International peer-reviewed scientific online journal

Published by
Faculty of
Biotechnology and
Food Sciences

A PERSPECTIVE ON THE PROS AND CONS, MANUFACTURING ASPECTS, AND RECENT ADVANCES IN NON-DAIRY MILK ALTERNATIVES

Jyotika Dhankhar

Address(es):
Department of Food Technology, Maharishi Dayanand University, Rohtak, Haryana, India-124001.

*Corresponding author: jyotika.ft@mdurohtak.ac.in

https://doi.org/10.55251/jmbfs.9543

ARTICLE INFO

Received 16. 10. 2022
Revised 17. 1. 2023
Accepted 18. 1. 2023
Published xx.xx.201x

Regular article

OPEN ACCESS

ABSTRACT

Cow's milk has served as a crucial part of the human diet for ages due to its nutritional benefits. However, in recent years, non-dairy milk alternatives (NDMAs) have surpassed cow's milk in its popularity due to different issues associated with cow's milk consumption. Although NDMAs contain additives, sweeteners, are deficient in good quality protein and entail a lack bioavailability of nutrients, they make for an appealing choice of consumers since they are a good source of bioactive components and carry a healthy fatty acid profile. Despite their popularity, there are concerns regarding their commercialization, as they lack stability upon storage and standardized technology for their large-scale production. The problems present a broad field for both the food industry and researchers to work synergistically in developing novel milk alternatives that are wholesome, healthy, cost-effective, and have better techno-functionality. This review comprehensively assesses the current scenario, health aspects, and production technologies in developing NDMAs, considering the accompanying challenges and promising prospects.

Keywords: Non-dairy milk alternatives (NDMAs), bioactive components, additives, bioavailability

INTRODUCTION

Milk comprises essential nutrients like proteins, minerals, lipids, and sugar necessary for human nutrition. It serves as the primary food source for newborns of mammals due to the presence in it of all vital nutrients necessary for proper development and growth **(Pereira, 2014)**. It contains an appreciable number of macronutrients and several micronutrients like minerals and vitamins **(Makinen *et al*., 2016).** However, the consumption of bovine milk has been facing a downward trend for the past decade due to a shift in consumers' preference for non-dairy milk alternatives (NDMAs) **(Haas *et al*., 2019)**. The major drivers for this trend are the consumer's demand for diverse flavors, health, environmental issues, and food sustainability **(Jeske *et al*., 2018).** The considerable interest is due to various health concerns related to milk consumption, such as lactose intolerance, cow milk protein allergy (CMPA), energy density, anemia, and proneness to coronary heart disease. Lactose intolerance affects almost 75% of the global population because of lack of lactase enzyme, which results in poor absorption of lactose and development of symptoms like bloating, abdominal discomfort, nausea, and diarrhea on the consumption of milk and dairy products **(Rodríguez *et al*., 2018; Facioni *et al*., 2020)**. Similar to intolerance, CMPA is another problem associated with milk consumption, though it appears primarily in the first three years of life and affects about 2 to 8% of the world population **(Lins *et al*., 2010)**. The allergic reaction occurs on milk ingestion against its protein components, triggers histamines and antibodies production with the manifestation of symptoms like hay fever, sneezing, coughing, or wheezing **(Mousan and Kamat,2016; Lifschitz and Szajewska, 2015)**.

Moreover, though milk is considered a whole food, it contains essential micronutrients such as iron, ascorbic acid, and folate in minor amounts, strengthening the ever-increasing demand for other alternatives **(Vanga *et al*., 2018)**. In addition to health reasons, restricted accessibility of milk in specific locations (desert areas or mountainous regions), high costs and occurrence of some pathogens responsible for foodborne illnesses, presence of antibiotic and pesticide residues have also contributed to an upsurge in consumers' preference for the milk alternatives. Environmental concerns such as greenhouse gas emissions from the livestock sector are also the critical issues that have driven customers to prefer non-dairy milk alternatives **(Gerber *et al*., 2010; Colak *et al*., 2007)**. According to the surveys on market trends, an increase in vegan labeled products, lesser price of milk alternatives, lower-calorie values, and increased ethical point of view of consumers for animal welfare have also played a crucial role in popularizing the vegan mindset.

Non-dairy milk alternatives are claimed to be a storehouse of health-promoting components that could augment the health conditions of consumers. The beneficial effects include potential antibacterial effects, antioxidant effects with free radical scavenging properties, cardioprotective effects, and effects of improved gut health. Given the ever-increasing interest of consumers in the vegan diet, expansion of the NDMAs business seems inevitable since the preference for novel foods corresponds to population requirements and consumer trends. NDMAs are water-soluble extracts of plant-based raw materials (cereals, pseudocereals, nuts, legumes, oilseeds) that are similar to bovine milk in appearance. Their manufacturing involves subjecting raw materials to different processing steps like size reduction, extraction of the raw material in water, followed by homogenization, and aseptic processing **(McClements *et al*., 2019; Reyes-Jurado *et al*., 2021)**.

The popular range of products available in the market includes soy, rice, almond, coconut, hemp, cashew, and oat milk. Concerning the manufacturing of different high-quality milk alternatives, their processing requires technological steps depending upon the base materials used for production. Since processing plays a crucial role in improving the shelf life and stability of plant-based beverages, processing steps have to be chosen judiciously depending on the raw material in use. The application of the same protocol for manufacturing non-dairy milk alternatives may cause discoloration and compromise the sensory quality of the final product. However, the general steps are somehow common for most of them which involve steps like size reduction, straining, mixing constituents, heat treatment, homogenization, aseptic processing, and refrigeration **(Silva *et al*., 2020; Sethi *et al*., 2016)**. The major target for the successful manufacturing of NDMAs is their stability and maintenance of sensorial attributes upon storage. Generally, incorporating various additives to improve physical properties is a common practice, using hydrocolloids, thickeners, and gums to increase stability, and salt and sweeteners help improve organoleptic properties. **(McClements *et al*., 2019; Paul *et al*., 2020; Aydar *et al*., 2020)**. Additionally, advanced technologies like high-pressure homogenization, ultrasonication, pulsed electric fields, etc., are also being explored these days to process some non-dairy milk alternatives. The present review discusses the composition of various milks, the pros and cons of various non-dairy milk alternatives on health, and various technological processes involved in their manufacturing.

Nutritional composition of non-dairy milk alternatives versus cow's milk

NDMAs tend to vary in their nutrient profile compared to cow's milk. Depending upon the product formulation and production process, the compositional characteristics of non-dairy milk alternatives may differ markedly. Table 1 enlists the differences in the nutritional attributes of non-dairy milks and cow's milk.

The milk alternatives are generally lower in protein content than cow's milk, which ranges from 3.15 to 3.37 %. Among the popular NDMAs, peanut milk, bean milk, and oat-based milks contain the highest overall protein content, ranging from 17 to 26 %, while sesame milk, almond milk, and rice milk have the lowest protein content. With regard to the variety of other plant milks, the protein content is almost equivalent to cow's milk. The standard term protein digestibility-corrected amino acid score (PDCAAS) is often used for assessing protein quality. It signifies protein digestibility and the primary limiting essential amino acid compared to the reference amino acids. An overestimation of the protein quality often does take place when food contains antinutritional factors, resulting in an inaccurate approximation of the protein quality due to the credit of additional nutritional value by the PDCAAS method **(Boye *et al*., 2012)**. The introduction of the concept of the digestible indispensable amino acid score (DIAAS) was hence done to help overcome the limitations of PDCAAS. DIAAS evaluates the actual intestinal amino acid digestibility of nutritionally essential amino acids **(Mathai, Liu & Stein 2017)**. Based on the literature review, it is evident that the quality of plant proteins is inferior to animal-based proteins due to many limiting amino acids resulting in lower PDCAAS than milk proteins **(Makinen *et al*., 2016)**. Methionine and cysteine are the essential amino acids usually deficient in plant proteins **(Krajcovicova-Kudlackova *et al*., 2005)**. Among plant proteins, cereal proteins essentially exhibit lower lysine content, whereas legume proteins display deficiency in cysteine and methionine content **(Schaafsma, 2000)**. The PDCAAS score reported in studies shows that milk protein quality is superior to the protein of any plant-based milk substitute. It is only in the case of soy protein that digestibility values compare well with that of bovine milk **(Makinen *et al*., 2016; Jeske *et al*., 2017)**. Soymilk possesses a well-proportioned amino acid profile that exhibits a DIAAS of 117%, thereby categorizing it as an "outstanding" quality protein source (DIAAS 100%) **(FAO, 2011)**. Other plant proteins, like almonds, oats, and rice, possess a DIAAS value of 40.00, 54.00, and 37.00–59.00, respectively, comparatively lower than soymilk's **(Scholz *et al*., 2020; Sousa *et al*., 2017)**.

For different non-dairy milk alternatives, carbohydrate content varies from 0.42 to 78 %, and few of them contain lesser content compared to milk (4.78 to 4.96 %). Concerning carbohydrate composition, lactose is the main carbohydrate present in bovine milk, facilitating the intestinal absorption of minerals, like calcium, phosphorus, and magnesium, whereas non-dairy milk alternatives are lactose-free. To improve the taste and flavor, NDMAs are often added with ingredients including sucrose, maltodextrin, agave syrup, and apple juice, which contributes to the higher carbohydrate content of the product.

Regarding fats, non-dairy milks typically have higher unsaturated fatty acid (monounsaturated and polyunsaturated) content compared to bovine milk. Vegetable oils are often added to NDMAs to improve the delectability of these products. Among the different non-dairy milk alternatives studied, monounsaturated fatty acid (MUFA) levels are highest in hazelnut drink (80%), hemp milk (74%) and lowest in soy drink (22%). The most commonly characterized MUFA in the NDMAs is oleic acid. The deviation from the trend is typical in the coconut-based milk alternatives since they contain a higher amount of saturated fatty acids than cow's milk and milk alternatives.

Since milk alternatives are usually mineral deficient, fortification is the standard protocol in most commercial brands. Calcium is one of the most abundant (1200 ppm) micronutrients in cow's milk and is vital for strengthening bone and teeth structure, functioning of muscle, and conducting of nerve impulses (National Institutes of Health, 2016). For brands available in the market, milk alternatives are fortified with calcium up to a range of 1250 ppm for equating to the level of cow's milk **(Craig and Fresán, 2021)**. Among other minerals, magnesium is also a vital micronutrient present in milk, having a content of almost about 140 ppm (FAO, 2011). Data available from studies show that magnesium levels in non-dairy milk beverages may vary from 7 to 1020 ppm **(Institute of Medicine, 1997)**. However, iron is deficient in bovine milk (0.5 ppm), while in NDMAs, it may vary from 1 to 14 ppm. Likewise, sodium levels (0.00 to 3450 ppm) are higher in NDMAs than in bovine milk (500 ppm). Similarly, vitamins A, D, E and folate, thiamin, riboflavin, B12, etc., are also added to improve their levels in milk alternatives. However, there are problems associated with fortifying vitamins and minerals due to their tendency to get reduced or degraded in the presence of oxygen and exposure to high temperatures **(Richardson, 1990)**.

Table 1 Nutritional attributes of different non-dairy milk alternatives versus cow's milk

Milk type	TS (%)	Lipids (%)	Carb (%)	Ash (%)	P (%)	Fibers (%)	pH	References
Cow milk	13.49	3.40-6.40	3.20-5.40	0.72	2.90-6.00	*	6.5	**(Paul *et al*. 2020; Vanga *et al*. 2018; Park 2009)**
Rice milk	12.8	0.85-2.34	9.41-25.28	0.11-0.47	0.07-1.26	0.31-0.64	5.20-6.12	**(Pineli *et al*. 2015; Faccin *et al*. 2009; Sousa *et al*. 2017; Mitchell *et al*. 1988)**
Almond milk	3.35-8.12	1.07-8.86	0.08-4.70	0.09-3.04	0.80-2.50	0.58-1.35	5.72-6.92	**(Bernat *et al*. 2015; Dhakal *et al*. 2014; Alozie Yetunde *et al*. 2015; Munekata *et al*. 2020)**
Oat milk	7.31-22.63	0.21-0.37	2.75-7.34	0.48	0.53-0.97	0.80-20.07	4.38	**(Syed *et al*. 2020; Sterna *et al*. 2016; Makinen *et al*. 2016; Sangami *et al*. 2018)**
Hemp milk	*	1.25-5.00	0.30-20.00	0.43	0.83-4.00	0.4	*	**(Vahanvaty 2009; wang *et al*. 2018; Chalupa-Krebzdak *et al*. 2018)**
Soy milk	8.11	2.35-4.35	4.64-5.00	0.81-0.84	2.36-8.71	0.64-0.74	6.90-7.40	**(Omoni *et al*. 2005; Mazumdar *et al*. 2016; Manzoor *et al*. 2017; Shen *et al*. 2019)**
Peanut milk	11.8-12.3	2.40-4.30	5.50-7.50	0.16-0.62	2.05-5.83	8.00-8.50	6.82-6.85	**(Yadav *et al*. 2018, Adesola *et al*. 2013; Jain *et al*. 2013)**
Sesame milk	10.19-13.91	6.15-8.02	4.04-16.50	0.22-0.48	1.50-2.97	0.10-0.20	6.81-8.23	**(Namiki 2007; Afaneh *et al*. 2011; Ahmadian-Kouchaksaraei *et al*. 2014)**
Pistachio milk	9.50-10.30	5.20-5.80	*	*	3.00-4.00	*	6.50-8.50	**(Shakerardekani *et al*. 2013)**
Coconut milk	14.00-25.27	4.12-34.70	3.75-9.41	0.52-1.30	0.59-3.60	5.30-5.98	6.09-6.61	**(Patil *et al*. 2018; Abdullah *et al*. 2018, Seow *et al*. 1997; Dhankhar *et al*. 2019)**
Tigernut milk	6.57-23.20	1.90-6.10	2.31-11.00	0.70-1.50	0.50-7.40	0.53-0.70	6.21-7.40	**(Ukwuru *et al*. 2011; Sanful 2009; Okyere *et al*. 2014)**
Melon seed milk	7.97-13.00	4	3.4	0.40-1.10	2.03-3.67	*	5.86-6.45	**(Akubor 1998; Akubor and Ogbadu 2003)**
Common bean milk	*	0.66-3.40	53.20-77.00	1.90-2.00	17.70-26.80	6.40-7.20	*	**(Anino *et al*. 2019; Hayat *et al*. 2014)**
Amaranth milk	*	0.6	3.07	0.43	3.42	1.9	10	**(Manassero *et al*. 2020)**
Millet milk	9.17	0.50-0.68	78.73	0.35-1.69	0.55-9.17	0.9	4.5-6.47	**(Dhankhar *et al*. 2019; Nair *et al*. 2019)**

Legend: TS- Total Solids, Carb- Carbohydrate, P- Protein, *- NA

Health aspects of non-dairy milk alternatives

Positive effects

Non-dairy milk alternatives are purported to be good sources of proteins, fibers, unsaturated fatty acids, polyphenols, and antioxidants. The health-promoting components are known for their potential in reducing the risk of various ailments like inflammation, cancer, cardiovascular diseases, atherosclerosis, diabetes, etc. **(Maleki *et al*., 2015)**. Phenolic compounds present in plant materials are exclusively constituted by flavan-3-ols, lignans, phenolic acid, isoflavones, flavonols, proanthocyanidins, flavanones, and anthocyanin **(Dai and Mumper, 2010; Dykes and Rooney, 2007)**. Soy milk beverages possess a higher antioxidant capacity (300 µM TEAC) and total phenolic content than oat beverages (300 µM TEAC vs. 100 µM TEAC; 25–30 vs.15 mg/100 mL) **(Moretto *et al*., 2021)**. In the case of pistachios, the TPC was about 116 -118 mg GAE/g; as to the DPPH test, 14.99 mg of pistachios required to scavenge 50 moles of initial DPPH; 2.19 mmol Trolox/g of sample for ABTS radical; the superoxide anion has an IC50 of 3.25 mg/g of sample **(Tomaino *et al*., 2010)**. Almonds contain phenolic content around 159 mg GAE/100 g and exhibit an antioxidant value of 891 µmol TE/100 g **(Bolling *et al*., 2010)**. Similarly, sesame has a total phenolic content of 29.9 mg catechin equivalents and DPPH at 5–40 µg/mL **(Shahidi *et al*., 2006)**.

From the data available, it is evident that the raw materials for NDMAs are an excellent source of bioactive components; still, there is no concrete evidence verifying their content in the final product. It is noteworthy that research is scarce on the thorough analysis of health-promoting components in NDMAs. Considering the number of processing steps (soaking, roasting, blanching, milling, pasteurization, homogenization, etc.) involved during the manufacturing of NDMAs, there is a high probability of less concentration of the compounds left in the final product. Many studies have demonstrated that the skins contain 5-10% of the total weight of nuts, cereals, and oilseeds, but most of the flavonoids are predominantly present in them **(Milbury *et al*., 2006; Alasalvar and Bolling, 2015)**. Since peeling or dehulling are standard operations in the processing of most NDMAs, it seems probable that the final product obtained could be devoid of many bioactive compounds associated with the original raw materials.

Soymilk is popular among consumers as it is an excellent source of bioactive compounds, isoflavones. Isoflavones are flavonoids that resemble estrogen in their structure and demonstrate activities like the hormone **(Bolca, 2014)**. The compounds are predominantly present in soybean as inert glycosides, such as daidzin, genistin, and glycitin, which undergo hydrolysis in the alimentary canal to aglycones- daidzein, genistein, and glycitein, respectively **(Setchell *et al*., 2002)**. Since genistein is a phytoestrogen that can bind to estrogen receptors and produce estrogen-like effects, it is frequently used to replace the conventional hormone therapy used to treat coronary diseases in postmenopausal women. It is known to induce beneficial cardioprotective effects by altering cell-specific genes upon interaction with nuclear estrogen receptors. Clinical studies demonstrate that genistein increases nitric oxide production and improves endothelial-mediated vasodilation in healthy postmenopausal women **(Crisafulli *et al*., 2005)**.

Additionally, the compound also exerts a positive influence on glucose metabolism by inhibiting tyrosine kinase activity and regulating insulin-mediated glucose release. Postmenopausal syndrome, which occurs upon aging in females due to reduction in estrogen levels, includes adverse dermal alterations, reduced collagen levels, laxity of skin, and postponed recovery process of wounds, has been studied to be mitigated upon administration of estrogen. It has been seen that supplementation of estrogen in diet assists in recovery from dermal breakdown due to its capability to bind to the estrogen receptor **(Genant *et al*., 1997)**. Research has shown that a daidzein metabolite, equol, generated by gut bacteria, exerts a more robust hormonal response than other phytoestrogens **(Setchell *et al*., 2002)**. S-equol exhibits structural similarity to estradiol enabling it to help reduce menopausal symptoms. Therefore, the greater efficiency of daidzein as observed in equol producers is due to the greater affinity of binding of equol to estrogen receptor than daidzein **(Setchell *et al*., 2002)**. Research studies demonstrate that dietary intake of daidzein and genistein enhances the bioavailability of other isoflavones and modifies the response to P-glycoprotein binding drugs in the intestine. They tend to exert their effect by improving the activity of P-glycoprotein in intestinal mucosal cells **(Okura *et al*., 2010)**. Glycitein, another isoflavone of importance in soy milk, though present in lower amounts and has a lower binding affinity to estrogen receptors, can exert a more potent estrogenic response than other isoflavones **(Hsiao *et al*., 2020)**.

Isoflavone content in soymilk ranges from 1.10–31.03 mg /100 g **(Bhagwat *et al*., 2008)**. Isoflavones are more bioavailable in liquid soymilk than in dense food matrix, like textured soy protein, as bioavailability varies according to the matrix type **(Cassidy *et al*., 2006)**. **Cassidy *et al*. (2006)** attributed higher isoflavone absorption to their high solubility because of the more excellent hydrophilicity of β-glucoside conjugates, leading to quicker absorption rates and faster peak serum levels after consumption of soy milk than in solid food. Soy is also abundant in saponins, triterpenoid glycosides that conjugate with aglycone to form sapogenol **(Berhow *et al*., 2006)**. These are classified A and B soyasaponins depending upon conjugated aglycone structure. Saponins possess health-beneficial properties, like anticarcinogenic, anti-inflammatory, and hepatoprotective effects **(Guang *et al*., 2014)**. Soyasaponin B content in soymilk is generally around 5.1 µmol g^{-1} **(Hu *et al*., 2004)**. The content of saponins and soyasapogenol B in soymilk varies as 393 nmol/g and 1.21 nmol/g, respectively **(Kamo *et al*., 2014)**.

In general, carbohydrate content in NDMAs is higher than in cow's milk. The carbohydrate comprises starch, fiber (soluble and insoluble), and added sweetener sources like maltodextrin, apple juice, agave syrup, maple syrup, etc. **Jeske *et al*. (2017)** investigated GI of bovine milk and 18 NDMAs, which ranged from 47.53 to 99.96, while in bovine milk, it was noted as 46.93. Of the different beverages evaluated, a low GI was observed in bovine milk, whereas among other NDMAs evaluated, the parameter varied depending on the type of sweetening agent added. It was noted that among the different NDMAs studied, the added sugar or sweeteners influenced the values of GI. For instance, upon the use of sweetening agent containing fructose as primary sugar, like, in agave syrup and apple concentrate, GI is potentially low compared to when the sweetening agent either contains sucrose, glucose, or maltose directly or in the form of syrup (maple syrup) or starch **(Jeske *et al*., 2017)**. The only exception is observed in oat-based milk, which, though contains high maltose content, demonstrates a moderate GI due to the glucose-lowering effect of beta-glucan in the milk alternative.

Dietary fibers are also present in variable levels and are an important part of carbohydrates present in NDMAs. Dietary fiber intake is associated with crucial physiological health benefits, such as the reduced risk of colonic cancer, intestinal disorders, type-II diabetes, cardiovascular disease, etc. **(Barber *et al*., 2020)**. Concerning the information on dietary fiber, limited data is available, and NDMAs likely contain more dietary fiber levels than cow's milk. It has been observed that oat milk intake of about 750 mL per day containing 0.5 g 100 g^{-1} of beta-glucan has an effect of lowering cholesterol levels **(Önning *et al*., 1999)**. According to the study, a daily dietary intake of oat milk for almost a month could lower total serum cholesterol and low-density lipoprotein (LDL) in consumers with reasonably higher cholesterol levels. However, this amount in oat milk may not be sufficient to meet the recommended uptake of a 3 g daily dose of soluble fiber to reduce LDL cholesterol **(Whitehead *et al*., 2014)**. The content of nutrients in commercially available NDMAs is often not displayed on labels; variation is also observed in different brands depending upon their formulations and the processing technologies involved.

The fat in nuts and cereals characteristically contains more unsaturated fatty acids (MUFA & PUFA) than SFA. Therefore, it can be expected that NDMAs derived from them should also reflect the same trend. The type and total content of dietary fat play an important role in preventing chronic ailments such as cardiovascular disease, hypertension, inflammation, diabetes mellitus, and cancer **(Kaur *et al*., 2014)**. A high plasma low-density lipoprotein (LDL) cholesterol level is a common underlying cause of cardiovascular disease. The risk of disease can be mitigated by lowering the dietary intake of saturated fatty acids and substituting MUFAs or PUFAs. Unsaturated fatty acids exert their cardioprotective effects through multiple mechanisms, including diminishing arrhythmias and modification of synthesis of prostaglandins, thereby reducing inflammation and improving platelet and endothelial function. Studies have shown that increased HDL-cholesterol and decreased triglycerides are observed on supplementation of the diet with MUFAs **(Kris-Etherton *et al*., 1999)**. Coconut milk alternatives are a good source of medium-chain triglycerides (MCT) that exert their favorable effects on cholesterol level, and metabolism, notwithstanding the adverse effects of saturated fatty acids, which are also present in high amounts **(Cardoso *et al*., 2015)**. With regards to the investigation of health benefits on its intake, it was observed in a study that daily consumption of coconut milk (200 ml) obtained upon reconstitution from coconut powder for eight weeks helped decrease LDL levels and improve HDL levels simultaneously **(Ekanayaka *et al*., 2013)**.

PUFAs influence several brain functions, such as signal communication, cell growth, and inflammation, impacting memory and cognitive functions. The polyunsaturated fatty acids (PUFAs) form an inherent part of the phospholipid cell membrane and act as precursors of signaling molecules. Research has shown that certain nutritional disorders or deficiencies are often related to impaired cognitive functions and neurodegenerative diseases **(Bryan *et al*., 2004)**. NDMAs containing high levels of PUFAs may help improve brain functions. PUFAs are essential in brain functioning by imparting membrane fluidity and inducing neurogenesis. Moreover, clinical studies illustrate the beneficial role of PUFA in controlling the ailments like Type 2 diabetes mellitus and CVD by controlling numerous metabolic pathways like decreasing blood triglycerides levels, promoting fat oxidation by preventing the action of transcription factors like promoting the activity of PPAR alpha and PPAR gamma, and inhibition of SREBP-1 for reducing lipogenesis. All these factors help decrease insulin sensitivity and improve fatty acid metabolism with the implication of control in diabetes and coronary diseases **(Ruxton *et al*., 2004)**.

Phytosterols, generally known as plant sterols and stanol esters, are naturally occurring compounds found in plant cell membranes. The beneficial effects of phytosterols are mediated through several mechanisms, including cardioprotective, anti-inflammation, antioxidant, antimicrobial effects, and promotion of wound healing **(Salehi *et al*., 2021)**. Since phytosterols are similar in structure to cholesterol, they interfere with cholesterol absorption in the body **(Genser *et al*., 2012)**. Additionally, phytosterols exert their anticarcinogenic effect on host systems by improving host responses, including enhancing the immune recognition of cancer, inducing hormonal dependent control of growth of endocrine tumors, and modifying sterol biosynthesis. Phytosterols also exhibit their anticarcinogenic properties by preventing tumor growth, including decreasing the progression of the cell cycle, the initiation of apoptosis, and the checking of tumor metastasis **(Kritchevsky and Chen, 2005)**.

Negative Effects

Cow's milk possesses a balanced nutritional profile in high-quality protein consisting of almost all essential amino acids, minerals, and vitamins (vitamins A, D, E, and B12). Although NDMAs are popular as the perfect substitute for cow's milk, they often do not meet its nutritional attributes. Therefore, several NDMAs brands have fortified nutrients in their products to make them nutritionally comparable to cow's milk. However, data on the bioavailability of these components upon fortification is not available. The milk alternatives have also raised concerns among consumers because though these products are fortified, nutrients might not be readily absorbable because of their limited bioavailability **(Vanga and Raghvan, 2018; Silva *et al*., 2020)**. The bioavailability of an ingested nutrient refers to the extent to which it is absorbed by the body and is determined by a range of activities, including digestion, absorption, transportation, utilization, and excretion **(Srinivasan, 2001)**. The main concern with the fortification of NDMAs is that, even though food is reasonably fortified, it is still unlikely that a particular nutrient will be absorbed to a similar extent to a reference food because of variation in bioavailability of nutrients in different food matrices. For instance, though milk is known to be a good source of calcium (119 mg/100 g of milk), plant-based sources contain considerably higher levels, with the total amount of calcium in 100 g of almonds, rice, and soybean being 325.29, 245.50, and 205.86 mg, respectively **(Vanga and Raghavan, 2018)**. However, in the case of plant-based diets, calcium bioavailability is affected negatively by antinutrients, like phytates and oxalates.

Antinutritional factors pose a limitation concerning the fortification of NDMAs because they restrict the bioavailability of fortified nutrients. Antinutrients are compounds of natural or synthetic nature that prevent the absorption of nutrients and reduce the digestion, and assimilation of nutrients to result in harmful consequences. Regarding their effects, antinutrient sensitivity varies in individuals, and appropriate food processing helps eliminate antinutritional components. They are primarily present in appreciable amounts in raw materials, like cereals, legumes, and nuts. Antinutrients typically found in plant-based foods are lectins, phytic acids, tannins, goitrogens, saponins, trypsin inhibitors, protease inhibitors, α-amylase inhibitors, and oxalates **(Samtiya *et al*., 2020)**. Of all the antinutrients, phytic acid is one of the most common antinutrients that bind essential minerals (including calcium, zinc, iron, magnesium, and copper), resulting in the formation of insoluble mineral complexes minerals and thereby hindering their intestinal absorption **(Dendougui and Schwedt, 2004)**. Likewise, oxalate is present in high concentrations in almonds, cashews, and other nuts and exerts its harmful effects by inhibiting calcium absorption and inducing calcium kidney stone formation **(Mitchell *et al*., 2019)**. Lectins represent the non-immunological proteins or glycoproteins mostly present in cereals (0.5–8 mg/100 g) and nuts (35–150 µg/g). They act by binding or modifying carbohydrates (glycoproteins, glycolipids, and polysaccharides) for evasion of the immune system and, in turn, get transported throughout the body to cause diseases of the small intestine (leaky gut syndrome). Researches demonstrate that they compromise the integrity of the intestinal barrier, which results in the onset of various autoimmune diseases **(Popova and Mihaylova, 2019)**.

Another important class of antinutrients is trypsin inhibitors, predominantly in legumes like soybeans, chickpeas, and red beans ranging from 4.5- 6.7 mg/100 g. Trypsin inhibitors interfere with protein absorption and negatively impact human nutrition. The inhibitors undergo inactivation upon heat treatment, resulting in their denaturation; however, overheating for achieving complete denaturation of inhibitors may compromise food's overall nutritional value. Tannins are oligomeric compounds of flavan-3-ols and flavan-3, 4-diols that deposit on the bran portion of legumes (1.8–18 mg/g). The compounds display antinutritional properties by interfering with the digestion of nutrients and inhibiting the absorption of essential substances. They also exert their effect by binding proteins, inactivating digestive enzymes, and reducing protein digestibility **(Vagadia *et al*., 2017)**. As to their content in NDMAS, limited information is available in the literature; however, there is a high probability of these compounds getting inactivated during different processing steps in manufacturing milk alternatives.

Research shows that most antinutrient compounds are inactivated from raw materials during roasting, dehulling, soaking, blanching, thermal treatments, or the processing steps involved in the production of NDMAs. The antinutrients, which are proteinaceous, undergo their loss of activity due to denaturation, or aggregates formation, upon thermal treatment. Many latest advanced processing techniques have been used in the food industry to reduce the concentration of antinutrients in foods. For example, **Yuan *et al*. (2008)** recommended the use of UHT to reduce trypsin inhibitor activity. Different combinations of microwave time temperature and power input help improve the protein digestibility and decrease residual TIA **(Vagadia *et al*., 2018; Varghese & Pare, 2019; Vanga *et al*., 2020)**. High-pressure homogenization successfully reduces the activity of inhibitors to 1/3rd **(Poliseli-Scopel *et al*., 2012)**. Manothermosonication (MTS) employing ultrasound under moderate conditions of time and pressure (65°C and 400 kPa) could inactivate TI up to 90% **(Chantapakul *et al*., 2020)**. Ohmic heating treatment enables the inactivation of TIA up to 87% (Lu *et al*., 2015). Dielectric-barrier discharge (DBD) plasma treatment successfully destroys TI completely **(Li *et al*., 2017)**. Besides these techniques, naturally existing polyphenols like tea catechins and stevioside can potentially inhibit TI by the phenomenon of competitive inhibition due to binding at TI's reactive sites and finally suppressing its activity **(Liu *et al*., 2017; Liu *et al*., 2019)**. Membrane filtration technique like ultrafiltration (<10 kDa) decreases the phytate content of soymilk up to 33.7% **(Wang *et al*., 2018)**. In soymilk, a pronounced increase in solubility of minerals (calcium, iron, and zinc) during in vitro digestion is noted on the addition of phytase **(Theodoropoulos *et al*., 2018)**. **Chen *et al*. (2018)** reported that employing an immobilized enzyme technique using phytase effectively reduces phytate content. Fermentation is also beneficial in improving the bioavailability of nutrients because lactic acid bacteria act by degrading antinutrient factors or complex substrates into more bioavailable form and increasing nutritive value by generating micronutrients. Research shows that co-cultures of lactic acid bacteria (*L. acidophilus* and *L. plantarum; S. thermophilus* and *Bifidobacterium infantis*) are more efficient in degrading phytic acid and trypsin inhibitors than individual strains in different legumes **(Sanni *et al*., 1999; Rekha and Vijayalakshmi, 2010; Lai *et al*., 2013)**.

Besides the antinutrients, the bioavailability of nutrients depends on the kind and type of fortificant used for fortification. The extent of absorption differs contingent on fortificant type and the salt utilized; for instance, tricalcium phosphate has noticeably lesser absorption (75%) compared to milk, while calcium carbonate has similar to milk **(Kruger *et al*., 2003; Zhao *et al*., 2005)**. However, the salts used occasionally result in calcium insolubility and chalky aftertaste in the beverage. The addition of chelators (phosphates and citrate salts) and stabilizers generally helps overcome the problem **(Pathomrungsiyounggul *et al*., 2010)**. Studies have shown that calcium and vitamin D co-fortification improves calcium absorption **(Khazai *et al*., 2008)**. Likewise, ascorbate and retinol act synergistically to enhance iron absorption **(Teucher *et al*., 2004)**. Therefore, the WHO/FAO regulations for food fortification approve co-fortification of ascorbate and iron in an antinutrient-rich food **(Dahdouh, 2019)**. In addition to the lower bioavailability, sedimentation of added calcium is another problem responsible for the presence of residue at the bottom of the empty cartons, which hardly solubilizes even upon vigorous shaking. Heaney & **Rafferty (2006)** demonstrated that soy beverage, when not shaken, provided on an average 30% of the quantity of calcium mentioned on the nutrition label, whereas when shaken provided 59%. High-temperature processing conditions while manufacturing may destroy the fortificant; its stability should be considered for ensuring the bioavailability of nutrients in NDMAs **(Arcot *et al*., 2002; Huang *et al*., 2006)**.

Processing of Plant-based milk alternatives

Non-dairy milk alternatives (NDMAs) are aqueous dispersions prepared by disintegrating plant materials in an aqueous medium (wet grinding) followed by filtration to remove suspended particles. Although the production of NDMAs may involve diverse kinds of raw material, the general processing operation essentially remains the same for their manufacture **(Reyes-Jurado *et al*., 2021)**. Raw materials may be subjected to various pretreatments such as dehulling, soaking, blanching, defatting, roasting, and fermentation to improve extraction, nutritional quality, organoleptic characteristics, and reducing off-flavors **(Giri & Mangaraj 2012; Bridges 2018; Paul *et al*., 2020)**. Raw materials such as cowpeas, peanut, soy, tiger nut, cashew, and walnut require dehulling and soaking in hot water or alkaline solutions. It facilitates better extraction, reduces processing time, and increases the stability of the product. Soaking of plant materials in alkaline solutions containing sodium bicarbonate at 0.2-2% level can reduce beany and nutty flavors **(Sethi *et al*., 2016; Aydar *et al*., 2020)**. Similarly, blanching assists removal of testa/skin (almonds), reduction of microbial load, and elimination of off-flavors caused by trypsin inhibitors and lipoxygenases (soy, sesame, and peanuts) **(Pardeshi *et al*., 2014; Bolarinwa *et al*., 2018; Maria and Victoria, 2018)**. Fermentation facilitates improving nutritional attributes in raw materials such as soybeans, almonds, rice, and oats, due to the action of microbes on antinutrients. The roasting process as pretreatment enhances the product stability, solubility, aroma, and taste and reduces acidity, bitterness, and a chalky taste in the NDMAs **(Silva *et al*., 2020)**.

Wet milling helps manufacture NDMAs by grinding base material with water with subsequent homogenization. This production step has a pronounced effect on the final composition of the product. Different parameters influencing this step's efficiency are the quantity of solid to liquid ratio, time, temperature, kind of operation, and feed rate **(Reyes-Jurado *et al*., 2021)**. The amount of water used hence determines the concentration of the final product and varies as per requirement **(Seow and Gwee, 1997)**. Several studies have demonstrated the effectiveness of wet grinding in producing plant-based milk beverages using different types of cereals, nuts, and grains **(McClements *et al*.,2019; Aydar, 2020)**. After the wet milling, removing coarse particles from the slurry either by filtration using different filtering materials such as filter paper, muslin cloth, and double-layered cheesecloth or centrifugation helps manufacture a stable product **(Diarra *et al*., 2005; Lindahl *et al*., 1997)**. Generally, to enhance the efficiency of the separation step, two-stage clarification is performed that allows the fine particles in the suspending medium that improve the emulsion stability **(Rosenthal *et al*., 2003)**. In the case of high-fat raw material, filtration allows for the separation of excess fat using a separator; it can act as an ingredient in other food formulations **(Deep *et al*., 2017)**. Membrane filtration technology such as ultrafiltration may help manufacture these milk alternatives **(Naziri *et al*., 2017)**.

To achieve the product's better appearance, flavor, and quality, NDMAs are usually incorporated with other ingredients like vitamins, minerals, additives, sweetening agents, colorants, oils, stabilizers, and flavoring agents. Guar gum, lecithin, carrageenan, alginate, xanthan gum are the common stabilizers to improve the suspension stability of the NDMAs. Antioxidants such as ascorbic acid and citric acid help avoid oxidation. In addition, the addition of some preservatives such as sodium metabisulfite can aid in preserving these milk beverages **(Bridges, 2018; Kohli *et al*., 2017)**. Also, fortification is employed to improve the nutritional quality of the product; the common fortificants used are calcium carbonate, vitamin A, riboflavin, folic acid, ergocalciferol, and tocopherol **(Aydar *et al*., 2020)**.

The dispersed phase particles such as fat droplets, starch, protein, and other cellular materials are denser than water and tend to settle down after some time, causing product instability. Concerning the stability of NDMAs, it involves using either emulsifiers and hydrocolloids or reducing the size of particles in suspension and increasing their distribution **(Makinen *et al*., 2016)**. Homogenization enhances the emulsion stability by subdividing the oil droplets and aggregates, which avoids phase separation. During homogenization, high pressures increase the stability, clarity, and whiteness index of the NDMAs **(Lee and Rhee, 2003; Tangsuphoom and Coupland, 2005)**.

Heat treatments aid food preservation by eliminating microbes and deactivating enzymes for shelf-life extension and maintaining quality **(Cruz *et al.*, 2007)**. Thermal treatments such as pasteurization, sterilization, or ultra-high temperature (UHT) may improve the shelf life of the NDMAs by destructing microflora by a judicious combination of time and temperature **(Dhankhar *et al.*, 2020)**. Apart from this, several non-thermal techniques such as pulsed electric fields, microfiltration, ultra-high pressure, and ultrasound are also a choice and can be applied to enhance microbiological stability and sensory and nutritional quality NDMAs.

To ensure the high stability of the NDMAs, they are aseptically packed, and the products are stored at 4 °C for extended shelf life.

Innovative processing techniques for manufacturing non-dairy milk alternatives

The primary concern associated with NDMAs is their stability related to the particle size of the colloidal particles, the extent of protein solubility, and emulsion stability. NDMAs are emulsified products with poor physical stability due to larger fat globules/oil droplets, starch granules, and other particles from raw material present in the dispersed phase **(Briviba *et al.*, 2016)**. These dispersed particles affect the product stability by causing sedimentation and precipitation during storage due to their tendency to aggregate and may lead to a loss of quality. This phase separation tendency of NDMAs also impacts sensory attributes leading to sandy or chalky mouthfeel, reduced consistency, and aroma **(Civille *et al*., 1973)**. Moreover, these beverages are also susceptible to microorganisms due to their nutrient-dense profile, which may adversely affect product safety during storage resulting in inferior quality and reduced product shelf life. The overall stability of NDMAs in terms of the physical and microbial parameters are invariably enhanced using various innovative processing techniques that result in efficient size reduction and destruction of pathogenic microbes. Different advanced methods such as ultrasonication, high hydrostatic pressure processing, ohmic heating, and pulsed electric field are employed in the production of non-dairy milks to obtain better quality in the final product **(Okyere *et al*., 2014; Briviba *et al*., 2016; Cruz *et al*., 2007; Zaaboul *et al*., 2019; Ferragut *et al*., 2015; Dhakal *et al*., 2014; Sethi *et al*., 2016; Munekata *et al*., 2020; Aydar *et al*., 2020)**. These processes aim to create changes in the arrangement of constituents, leading to modifications in viscosity, color, and particle size, which increase the product's physical stability. In addition, these technologies also enhance microbiological stability by inactivating microorganisms and enzymes. The overall aspects of raw materials and various processing steps have been depicted in Figure 1 and the impact of processing technologies for accomplishing the stability of NDMAs is discussed in Table 2. Different thermal processing operations like sterilization, pasteurization, and ultra-high temperature (UHT) processing have proven successful in enhancing stability and imparting stability to NDMAs. Due to the heating effect, these treatments induce changes in food components such as denaturation of protein and better extractability of fat that leads to stabilizing emulsion **(Sethi *et al*., 2016)**. The heat treatments facilitate the extension of the shelf life of NDMAs by effectively destroying spoilage and pathogenic microorganisms. Steam blanching of almonds and subsequent pasteurization can successfully eliminate the microbes in almond milk **(Maria & Victoria, 2018)**. Research studies show that the higher the treatment temperature for a processing operation, such as sterilization and UHT, the more shelf life is attained for the final product. In the case of sterilized soymilk, storage life is 90 days at room temperature, and upon refrigeration, there is a shelf-life extension to 170 days **(Khodke *et al*., 2015)**. In a similar study, **Kwok *et al*. (2002)** reported that the single-step UHT process employing conditions at 143ºC for 1 minute was efficacious in developing commercially sterile soymilk, demonstrating pleasing organoleptic properties, good nutrient retention, and antinutrient destruction.

In general, when NDMAs are heated, interactions between proteins increase due to increased hydrophobicity generated by non-polar amino acids interacting with water. This interaction causes sedimentation or gelling, resulting in increased viscosity **(Silva *et al*., 2020)**. High starch concentration is also a problem in processing NDMAs as the starch may get gelatinized during heat treatments which can influence the quality characteristics of the formulated product. Therefore, the application of non-thermal processes as an alternative to thermal treatments is potentially suitable for shelf-life extension and maintaining the quality characteristics of NDMAs **(Reyes-Jurado *et al*., 2021)**. Technologies such as high-pressure homogenization, microwave heating, UHPH, ultrasound, and pulsed electric field processing may effectively replace the thermal methods as they also enhance the sensory and nutritional attributes of non-dairy milk alternatives.

High-pressure treatment is an option for thermal treatments as it retains most of the food qualities by minimizing the thermal damage of the product. This treatment has fewer effects on low molecular weight components, for instance, vitamins, pigments, and flavor compounds, and can also be applied to improve microbiological quality **(Silva *et al*., 2020)**. In a study, ultra-high-pressure homogenization of almond milk and soymilk showed better overall quality attributes than conventional heating **(Ferragut *et al*., 2011)**. Similarly, high-pressure treatment (300 MPa, 65°C) improved traditional pasteurization, and results showed no bacterial growth during 20 days at 30°C incubation temperature **(Valencia-Flores *et al*., 2013)**. Ultrasound treatment is another non-thermal technology that affects foods' physical and biochemical characteristics **(Awad *et al*., 2012)**. It consists of high-frequency vibrations that cause cavitation and poration, which improve physical stability by increasing or decreasing viscosity in food products and can also be employed synergistically with other treatments for the destruction of microbes **(Sala *et al*., 1995; Ojha *et al*., 2017; Raso *et al*., 2003; Lee, 2003; Piyasena *et al*., 2003)**. Several studies have shown the antimicrobial efficacy of ultrasound in different liquid foods by resulting in the destruction of spoilage and pathogenic microbes associated with dairy foods **(Iorio *et al*., 2019; Van Impe *et al*., 2018; Sango *et al*., 2014; Awad *et al*., 2012; Bevilacqua *et al*.,2018)**. Microwave heating is a food processing method that allows for volumetric heating of food. This technique is of high thermal efficiency in generating heat in food, significantly lowers the processing time, and lessens the thermal degradation to functional components of the food product **(Sabliov *et al*., 2008)**. The evenly heating of the entire volume of food by microwaves leads to a reduction in overall heating time and is potent enough to achieve high temperatures necessary for commercial sterilization accomplishing successful microbial eradication **(Decareau, 1985).** Also, even though the processing temperatures are high, products are palatable for consumers without any trace of burnt or cooked flavor **(Vasavada, 1990)**.

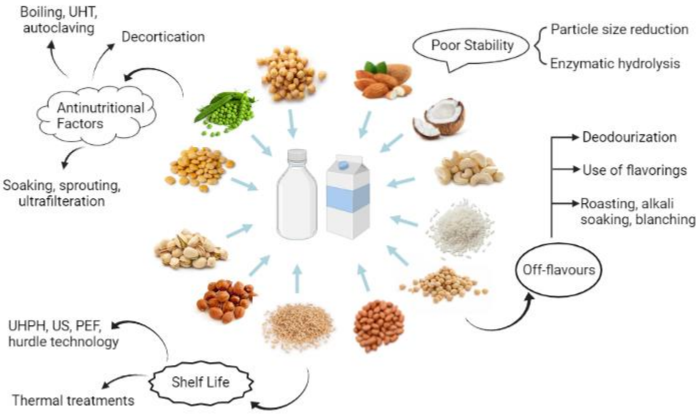

Figure 1 Main concerns related to manufacturing of Non-dairy milk alternatives and their solutions thereof

The pulsed electric fields technique is an effective non-thermal approach that treats the foods similarly to pasteurization though at low temperature by subjecting them to pulsed electric fields of high intensity. PEF technique uses short high voltage pulses that compromise the integrity of the microbial cell membrane through electroporation leading to cell damage and subsequent destruction of microbes **(Zimmermann, 1986)**. This novel non-thermal processing method is an effective approach carried out at low temperatures for accomplishing maximum retention of nutrients, maintenance of palatability, color as well as nutritional value, enhanced protein functionality, improved stability, maintenance of heat-sensitive bioactive components, and decreased levels of foodborne pathogens and deterioration microorganisms **(Tiwari *et al*., 2009; Amiali *et al*., 2007; Barbosa-Cánovas *et al*., 2006; Knorr *et al*., 2011; Van Impe *et al*., 2018; Stoica *et al*., 2011). Morales-de La Peña *et al*. (2010)** reported that the PEF approach considerably reduced *L. innocua* count in a soy beverage. Upon receiving the treatment using pulsed electric fields for 800 µs, samples had reduced microflora with a shelf life of almost a month, while the approach in combination with thermal treatment extended the shelf life up to 56 days. Similar observations were reported by **Li *et al*. (2013)**, who compared and studied the outcome of the PEF technique on *E. coli* 8739 population in soymilk beverage. They concluded that the treatment resulted in the inactivation of the natural microflora of soymilk, extended the shelf stability at refrigeration storage, and showed no significant impact on the beverage's color and viscosity throughout storage.

Apart from various processing technologies, some additives such as emulsifiers, novel food-based stabilizers, or thickening agents are used to enhance the stability, quality, and nutritional attributes of NDMAs. The effectiveness of emulsifiers in stabilizing emulsion depends on their ability to prevent droplet aggregation during storage. Emulsifiers also contribute to the shelf life, mouthfeel, flavor profile, and appearance of non-dairy milk alternatives. Plant-based emulsifiers include polysaccharides, proteins, biosurfactants, and phospholipids **(McClements *et al*., 2016)**. Each emulsifier's emulsion stabilizing ability differs when subjected to several environmental stresses, such as pH changes, high temperature, and salt concentrations **(Gumus *et al*., 2017)**. Thickening agents are known as texture modifiers as they enhance the viscosity, body, appearance and modify the product's mouthfeel. They also contribute to the stability of the non-dairy milk alternatives by inhibiting the gravitational separation of the fat droplets (creaming) and protein aggregates (sedimentation) **(McClements *et al*., 2019)**. Several natural biopolymers like pectin, xanthan gum, guar gum, starch, carrageenan, and alginates can be used as thickening agents in non-dairy milk alternatives. The particular type and concentration of emulsifier/stabilizer considerably influence the quality attributes of the NDMAs by imparting better physicochemical and rheological properties and improved colloidal stability.

Table 2 Different stability issues associated with production of non-dairy milk alternatives and use of innovative processing technologies to enhance stability

Issue	Cause	Processing techniques to enhance stability	Mode of Action	Process conditions	Effect on food product	References
Phase Separation	Larger size of fat globules; poor emulsion stability; protein insolubility	Ultrasound Processing	Reduces the droplet diameter	(2.5 to 7.0 W input power, 20 kHz frequency, 5 to 25 minutes exposure time)	Ultrasound treatment resulted in reduced fat particle size in coconut milk and prevented fat separation	**(Iswarin and Permadi, 2012)**
		Ultra high pressure homogenization	Stabilizes proteins in solutions, forms smaller and more uniform sized particles	(276 MPa pressure, 12.48 seconds)	UHPH treated soymilk showed significant reduction in particle size	**(Sidhu and Singh 2016)**
		Colloid milling	Reduces the size of dispersed phase particles	20-30 minutes blending time	Colloid mill comminuted pistachios producing a fine paste of kernels with reduced particle size of protein and fat globules	**(Shakerardekani *et al.*, 2013)**
		Heat treatments	Denaturation of proteins, better extractability of fat and increase in viscosity due to heating of starch	(above 100ºC temp)	Soymilk processed at high temperature resulted in reduced beany flavour and increased fat extractability and protein denaturation	**(Chauhan *et al.*, 2003)**
		High pressure throttling	Narrow down particle size distribution	(up to 276 MPa pressure)	High pressure throttling of soymilk (beans ground in a Megatron) produced soymilk with smallest particle size and the highest apparent viscosity	**(Sivanandan *et al.*, 2008)**
		Thickening agents and Emulsifiers	Prevents droplet aggregation during storage, retards the gravitational separation responsible for creaming and sedimentation	----	Peanut beverage stabilized with propylene glycol alginate, lecithin and xanthan gum showed better rehological and physicochemical properties	**(Gama *et al.*, 2019)**
Spoilage	Rapid growth of micro-organisms	Pasteurization	5 log reduction of microbial load	(72 ºC for 15 minutes)	Pasteurization of almondmilk resulted in reduced total viable cell count, yeast and mold count	**(Maria *et al.*, 2018)**
		Sterilization	Destruction of microbes by irreversible denaturation of proteins and enzymes	(121 ºC for 15 minutes)	Sterilization of soymilk increased the microbiological safety of the beverage upto 170 days at refrigerated condition	**(Khodke *et al.*, 2015)**
		Ultra-high temperature (UHT)	Increased bacterial lethality with reduced chemical interaction	(143ºC for 60 seconds)	Single step UHT process canresult into a commercially sterile soymilk with thiamin retention upto 93 %	**(Kwok *et al.*, 2002)**
		High pressure throttling	Rise in temperature by pressure release which inactivates microbes	(207 MPa and 276 MPa to atmospheric pressure)	Continuous flow high pressure throttling of inoculated soymilk resulted in reduced microbial load upto 6 log cycles	**(Sharma *et al.*, 2009)**
		Pulse electric field processing (PEF)	Membrane damage by electroporation	(20-40kV/cm, 0-547 µs)	PEF treatment in soymilk inactivated*E. coli* and *Staphylococcus aureus* more efficiently with increasing strength and treatment time	**(Li *et al.*, 2013)**
		High pressure homogenization (HPH)	Cell lysis caused by shear stress, shock waves, turbulence and velocity fluctuations	(60 MPa/38.8ºC)	UHPH treatment in Hemp milk resulted in reduced microbial growth by 3.2 $\log_{10}$ CFU/ml	**(Wang *et al.*, 2018)**
		Ultrasound Processing	Cell wall disruption through acoustic cavitation	(20 kHz, 130 W, 8 min)	Ultrasonication treatment of almond milk resulted in inhibition of *E. Coli* and *Listeria monocytogenes*	**(Iorio *et al.*, 2019)**

Final Remarks

The non-dairy milk alternative market is increasing, propelled by the latest trends, media platforms, consumer awareness, and a propensity toward healthier living. Despite the abundance of such drinks in the market, complete information is lacking concerning their nutritional profile. However, comprehensive scientific studies are a requisition for understanding the role of various bioactive components associated with the NDMAs and the impact of their consumption upon the replacement of bovine milk. Moreover, processors generally opt for using particular additives and fortifying agents voluntarily. The moot point in labeling them healthy involves a lack of factual information about the concentration of bioactive phytochemicals since they are a much-diluted version of the original raw materials. Also, no advanced processing technology is used extensively in their large-scale production. Such technologies warrant ample trials, and investigation of newer raw materials is required to develop stable and nutritionally enriched NDMAs. Conclusive studies are necessary to optimize a product sensorially as well as nutritionally. To gain customer approval due to their ever-evolving knowledge and propensity towards the novel food segment of NDMAs, the research community should undertake persistent endeavours to accomplish quality standards through research and development activities and innovative technologies. To summarise, it is plausible to understand that NDMAs will persist in being a prominent research field to be explored and require more scientists' inputs to make it a satisfying option for consumers looking for a healthy substitute to cow's milk.

Acknowledgement: This research did not receive any specific grant from funding agencies. The author thanks Department of Food Technology, Maharishi Dayanand University, Rohtak, Haryana, India for providing assistance.

Conflict of Interest: The author declares that there is no conflict of interest.

REFERENCES

Adesola, A. O., Olasunkanmi, G. S., & Kehinde, T. A. (2013). Effects of some processing factors on the characteristics of stored groundnut milk extract. *Australian Journal of French Studies*, 7, 134-142. http://dx.doi.org/10.5897/AJFS12.149.

Afaneh, I., Abu-Alruz, K., Quasem, J. M., Sundookah, A., Abbadi, J., Alloussi, S, & Ayyad, Z. (2011). Fundamental elements to produce sesame yoghurt from sesame milk. *American Journal of Applied Sciences*, 8(11), 1086-1092. https://dx.doi.org/10.3844/ajassp.2011.1086.1092

Ahmadian-Kouchaksaraei, Z., Varidi, M., Varidi, M. J. & Pourazarang, H. (2014). Influence of processing conditions on the physicochemical and sensory properties of sesame milk: A novel nutritional beverage. *LWT - Food Science and Technology*, 57(1), 299-305. http://dx.doi.org/10.3390/molecules24071338

Akubor, P. I. (1998). Physico-chemical and sensory characteristics of melon seed milk. *Journal of Food Science and Technology*, 35 (1), 93-95. Corpus ID: 99974123

Akubor, P. I. & Ogbadu, R. L. (2003). Effects of processing methods on the quality and acceptability of melon milk. *Plant Foods for Human Nutrition*, 58, 1-6. http://dx.doi.org/10.1023/a:1024063105507

Alasalvar, C. & Bolling, B. W. (2015). Review of nut phytochemicals, fat-soluble bioactives, antioxidant components and health effects. *British Journal of Nutrition*, 113, 68-78. http://dx.doi.org/10.1017/S0007114514003729

Alozie Yetunde, E. & Udofia, U. S. (2015). Nutritional and sensory properties of almond (Prunus *amygdalu Var Dulcis*) seed milk. *World Journal of Dairy & Food Sciences*, 10(2), 117-121. http://dx.doi.org/10.5829/idosi.wjdfs.2015.10.2.9622

Amiali, M., Ngadi, M. O., Smith, J. P. & Raghavan, G. S. V. (2007). Synergistic effect of temperature and pulsed electric field on inactivation of Escherichia coli O157: H7 and Salmonella enteritidis in liquid egg yolk. *Journal of Food Engineering*, 79(2), 689-694. http://dx.doi.org/10.1016/j.jfoodeng.2006.02.029

Anino, C., Onyango, A. N., Imathiu, S., Maina, J. & Onyangore, F. (2019). Chemical composition of the seed and 'milk' of three common bean (*Phaselous vulgaris* L) varieties. *Journal of Food Measurement and Characterization*, 13(2). http://dx.doi.org/10.1007/s11694-019-00039-1

Arcot, J., Wong, S., & Shrestha, A. K. (2002). Comparison of folate losses in soybean during the preparation of tempeh and soymilk. *Journal of the Science of Food and Agriculture*, 82(12), 1365-1368. http://dx.doi.org//10.1002/jsfa.1197

Awad, T. S., Moharram, H. A., Shaltout, O. E., Asker, D., & Youssef, M. M. (2012). Applications of ultrasound in analysis, processing and quality control of food. *Food Research International*, 48(2), 410-427. http://dx.doi.org/10.1016/j.foodres.2012.05.004

Aydar, E. F., Tutuncu, S. & Ozcelik, B. (2020). Plant-based milk substitutes: Bioactive compounds, conventional and novel processes, bioavailability studies, and health effects. *Journal of Functional Foods*, 70, 103975. http://dx.doi.org/10.1016/j.jff.2020.103975

Barber, T. M., Kabisch, S., Pfeiffer, A. F., & Weickert , M. O. (2020). The health benefits of dietary fibre. *Nutrients*, 12(10), 3209. http://dx.doi.org/10.3390/nu12103209

Barbosa-Cánovas, G. V. & Altunakar, B. (2006). Pulsed electric fields processing of foods: an overview. pp 3-26. In: *Pulsed electric fields technology for the food industry*. Raso J, Heinz V (ed).Springer, Boston, MA.

Berhow, M. A., Kong, S. B., Vermillion, K. E. & Duval, S. M. (2006). Complete quantification of group A and group B soya saponins in soybeans. *Journal of agricultural and food chemistry*, 54(6), 2035-2044. http://dx.doi.org/10.1021/jf053072o

Bernat, N., Cháfer, M., Rodríguez-García, J., Chiralt, A. & González-Martínez, C. (2015). Effect of high pressure homogenisation and heat treatment on physical properties and stability of almond and hazelnut milks. *LWT - Food Science and Technology*, 62(1), 488-496. https://doi.org/10.1016/j.lwt.2014.10.045

Bevilacqua, A., Petruzz,i L., Perricone, M., Speranza, B., Campaniello, D., Sinigaglia, M. & Corbo, M. R. (2018). Nonthermal technologies for fruit and vegetable juices and beverages: Overview and advances. *Comprehensive Reviews in Food Science and Food Safety*, 17(1), 2-62. http://dx.doi.org/10.1111/1541-4337.12299

Bhagwat, S., Haytowitz, D. B. & Holden, J. M. (2008). USDA database for the isoflavone content of selected foods, release 2.0. U.S. Department of Agriculture. http://dx.doi.org/10.15482/USDA.ADC/1209670

Bolarinwa, I. F., Aruna, T. E., Adejuyitan, J. A., Akintayo, O. A. & Lawal, O. K. (2018). Development and quality evaluation of soy-walnut milk drinks. *International Food Research Journal*, 25(5), 2033-2041.

Bolca, S. (2014). Bioavailability of soy-derived isoflavones and human breast cancer. pp 1241-1256. In: *Polyphenols in human health and disease*. Watson RR, Preedy VR, Zibadi S (ed.). Academic Press.

Bolling, B. W., Dolnikowski, G., Blumberg, J. B. & Chen, C. O. (2010). Polyphenol content and antioxidant activity of California almonds depend on cultivar and harvest year. *Food Chemistry*, 122(3), 819-825. http://dx.doi.org/10.1016/j.foodchem.2010.03.068

Boye, J., Wijesinha-Bettoni, R. & Burlingame, B. (2012). Protein quality evaluation twenty years after the introduction of the protein digestibility corrected amino acid score method. *The British Journal of Nutrition*, 108 (S2), S183-211. http://dx.doi.org/10.1017/S0007114512002309

Bridges, M. (2018). Moo-ove over, cow's milk: The rise of plant-based dairy alternatives. Practical Gastroenterology: *Nutrition Issues in Gastroenterology*, 173, 20-27. https://med.virginia.edu/ginutrition/wp-content/uploads/sites/199/2014/06/January-18-Milk-Alternatives.pdf

Briviba, K., Gräf, V., Walz, E., Guamis, B. & Butz, P. (2016). Ultra high pressure homogenization of almond milk: Physico-chemical and physiological effects. *Food Chemistry*, 192, 82-89. http://dx.doi.org/10.1016/j.foodchem.2015.06.063

Bryan, J., Osendarp, S., Hughes, D., Calvaresi, E., Baghurst, K. & van Klinken, J. W. (2004). Nutrients for cognitive development in school-aged children. *Nutrition reviews*, 62(8), 295-306. http://dx.doi.org/10.1111/j.1753-4887.2004.tb00055.x

Chalupa-Krebzdak, S., Long, C. J. & Bohrer, B. M. (2018). Nutrient density and nutritional value of milk and plant-based milk alternatives. *International Dairy Journal*, 87, 84-92. http://dx.doi.org/10.1016/J.IDAIRYJ.2018.07.018

Cardoso, D. A., Moreira, A. S., de Oliveira, G. M., Raggio Luiz, R. & Rosa, G. (2015). A coconut extra virgin oil-rich diet increases HDL cholesterol and decreases waist circumference and body mass in coronary artery disease patients. *Nutricion Hospitalaria*, 32(5), 2144-2152. http://dx.doi.org/10.3305/nh.2015.32.5.9642

Cassidy, A., Brown, J. E., Hawdon, A., Faughnan, M. S., King, L. J., Millward, J., Zimmer-Nechemias, L., Wolfe, B. & Setchell, K. D. (2006). Factors affecting the bioavailability of soy isoflavones in humans after ingestion of physiologically relevant levels from different soy foods. *The Journal of nutrition*, 136(1), 45-51. http://dx.doi.org/10.1093/jn/136.1.45

Chantapakul, T., Tao, W., Chen, W., & Liao, X. (2020). Manothermosonication: Inactivation and effects on soymilk enzymes. *Ultrasonics sonochemistry*, 64, 104961. http://dx.doi.org/10.1016/j.ultsonch.2020.104961

Chauhan, G. S., Yadav, D. N. & Agrawal, K. (2003). Development of beany flavour free soymilk and soy paneer. *Processed Food Industry*, 6, 13-22.

Chen, K. I., Chiang, C. Y., Ko, C. Y., Huang, H. Y., Cheng, K. C. (2018). Reduction of phytic acid in soymilk by immobilized phytase system. *Journal of food science*, 83(12),2963-2969. http://dx.doi.org/10.1111/1750-3841.14394

Civille, G. V. & Szczesniak, A. S. (1973). Guidelines to training a texture profile panel. *Journal of texture studies*, 4(2), 204-223. https://doi.org/10.1111/j.1745-4603.1973.tb00665.x

Colak, H., Hampikyan, H. & Bingol, E. B. (2007). Some residues and contaminants in milk and dairy products. *Asian Journal of Chemistry*, 19(3), 1789-1796. https://asianjournalofchemistry.co.in/User/ViewFreeArticle.aspx?ArticleID=19_3_22

Craig, W. J. & Fresán, U. (2021). International Analysis of the Nutritional Content and a Review of Health Benefits of Non-Dairy Plant-Based Beverages. *Nutrients*, 13(3), 842. http://dx.doi.org/10.3390/nu13030842

Crisafulli, A., Altavilla, D., Marini, H., Bitto, A., Cucinotta, D., Frisina, N., Corrado, F., D'Anna, R., Squadrito, G., Adamo, E. B., Marini, R., Romeo, A., Cancellieri, F., Buemi, M. & Squadrito, F. (2005). Effects of the phytoestrogen genistein on cardiovascular risk factors in postmenopausal women. *Menopause*, 12(2), 186-192. http://dx.doi.org/10.1097/00042192-200512020-00013

Cruz, N., Capellas, M., Hernández, M., Trujillo, A. J., Guamis, B. & Ferragut, V. (2007). Ultrahigh pressure homogenization of soymilk: Microbiological, physicochemical and microstructural characteristics. *Food Research International*, 40, 725-732. http://dx.doi.org/10.1016/j.foodres.2007.01.003

Dahdouh, S., Grande, F., Espinosa, S. N., Vincent, A., Gibson, R., Bailey, K., King, J., Rittenschober, D., & Charrondière, U. R. (2019). Development of the FAO/INFOODS/IZINCG global food composition database for phytate. *Journal of Food Composition and Analysis*, 78, 42-48. http://dx.doi.org/10.1016/j.jfca.2019.01.023

Dai, J., & Mumper, R. J. (2010). Plant phenolics: extraction, analysis and their antioxidant and anticancer properties. *Molecules*, 15(10), 7313-7352. http://dx.doi.org/10.3390/molecules15107313

Decareau, R. V. (1985). Microwaves in the Food Processing Industry. Academic Press Inc., Orlando.

Deep, N. Y., Sangita, B., Arvind, K. J., & Ranjeet, S. (2017). Plant based dairy analogues: An emerging food. *Agricltural Research and Technology*, 10, 23-26. http://dx.doi.org/10.19080/ARTOAJ.2017.10.555781

Dendougui, F., & Schwedt, G. (2004). In vitro analysis of binding capacities of calcium to phytic acid in different food samples. *European Food Research and Technology*, 219(4), 409-415. http://dx.doi.org/10.1007/s00217-004-0912-7

Dhakal, S., Liu, C., Zhang, Y., Roux, K. H., Sathe, S. K., & Balasubramaniam, V. M. (2014). Effect of high hydrostatic pressure on the immunoreactivity of almond milk. *Food Research International*, 62,215-222. http://dx.doi.org/10.1016/j.foodres.2014.02.021

Dhankhar, J., & Kundu, P. (2021). Stability aspects of non-dairy milk alternatives. Milk-substitutes- selected aspects. *Intechopen*. http://dx.doi.org/10.5772/intechopen.96376

Dhankhar, J., Sunny, Kundu, P., & Mehla, R. (2019). Preparation and physicochemical evaluation of dairy free alternative based on coconut and millet milk. *International Journal of Pharmacy and Biological Sciences,* 9 (1), 565-572. https://www.ijpbs.com/ijpbsadmin/upload/ijpbs_5c86352be1920.pdf

Diarra, K., Nong, Z. G., & Jie, C. (2005). Peanut milk and peanut milk based products production: a review. *Critical reviews in food science and nutrition*, 45(5), 405-423. http://dx.doi.org/10.1080/10408390590967685

Dykes, L., & Rooney, L. W. (2007). Phenolic compounds in cereal grains and their health benefits. *Cereal foods world*, 52(3), 105-111. http://dx.doi.org/10.1094/CFW-52-3-0105

Ekanayaka, R. A., Ekanayaka, N. K., Perera, B., & De Silva, P. G. (2013). Impact of a traditional dietary supplement with coconut milk and soya milk on the lipid profile in normal free living subjects. *Journal of nutrition and metabolism*, 481068. http://dx.doi.org/10.1155/2013/481068

Faccin, G. L., Vieira, N., Miotto, L. A., Barreto, P. L. M., & Amante, E. R. (2009). Chemical, sensorial and rheological properties of a new organic rice bran beverage. *Rice Science*, 16, 226-234. http://dx.doi.org/10.1016/S1672-6308(08)60083-9

Facioni, M. S., Raspini, B., Pivari, F., Dogliotti, E., & Cena, H. (2020). Nutritional management of lactose intolerance: the importance of diet and food labelling. *Journal of Translational Medicine*, 18, 260. http://dx.doi.org/10.1186/s12967-020-02429-2.

Ferragut, V., Hernández-Herrero, M., Poliseli, F., Valencia, D., & Guamis, B. (2011). Ultra High Pressure Homogenization (UHPH) Treatment of Vegetable Milks: Improving Hygienic and Colloidal Stability. In: Proceedings of the 11th International Congress on Engineering and Food, Athens, GR.

Ferragut, V., Hernández-Herrero, M., Veciana-Nogués, M. T., Borras-Suarez, M., González-Linares, J., Vidal-Carou, M. C., & Guamis, B. (2015). Ultra-high-pressure homogenization (UHPH) system for producing high-quality vegetable-based beverages: Physicochemical, microbiological, nutritional and toxicological characteristics. *Journal of the Science of Food and Agriculture*, 95(5), 953-961. http://dx.doi.org/10.1002/jsfa.6769

Food and Agriculture Organization. (2011). Dietary protein quality evaluation in human nutrition. *FAO Food and Nutrition Paper*, 92, 1-66. https://www.fao.org/documents/card/en/c/ab5c9fca-dd15-58e0-93a8-d71e028c8282/

Gama, A. P., Hung, Y. C., & Adhikari, K. (2019). Optimization of emulsifier and stabilizer concentrations in a model Peanut-Based beverage system: a mixture design approach. *Foods*, 8(4), 116. http://dx.doi.org/10.3390/foods8040116

Genant, H. K., Lucas, J., Weiss, S., Akin, M., Emkey, R., McNaney-Flint, H., Downs, R., Mortola, J., Watts, N., Yang, H. M., Banav, N., Brennan, J. J., & Nolan, J. C. (1997). Low-dose esterified estrogen therapy: effects on bone, plasma estradiol concentrations, endometrium, and lipid levels. *Archives of internal medicine*, 157(22), 2609-2615. http://dx.doi.org/10.1001/archinte.157.22.2609

Genser, B., Silbernagel, G., De Backer, G., Bruckert, E., Carmena, R., Chapman, M. J., Deanfield, J., Descamps, O. S., Rietzschel, E. R., Dias, K. C., März, W. (2012). Plant sterols and cardiovascular disease: a systematic review and meta-analysis. *European Heart Journal*, 33(4), 444-451. http://dx.doi.org/10.1093/eurheartj/ehr441

Gerber, P., Vellinga, T., Opio, C., Henderson, B., & Steinfeld, H. (2010). Greenhouse gas emissions from the dairy sector. *A life cycle assessment* pp. 1-94. FAO Food and Agriculture Organisation of the United Nations, Animal Production and Health Division, Rome. https://www.fao.org/3/k7930e/k7930e00.pdf

Giri, S. K., & Mangaraj, S. (2012). Processing influences on composition and quality attributes of soymilk and its powder. *Food Engineering Reviews*, 4(3), 149-164. http://dx.doi.org/10.1007/s12393-012-9053-0

Guang, C., Chen, J., Sang, S., & Cheng, S. (2014). Biological functionality of soyasaponins and soyasapogenols. *Journal of agricultural and food chemistry*, 62(33), 8247-8255. http://dx.doi.org/10.1021/jf503047a

Gumus, C. E., Decker, E. A., & McClements, D. J. (2017). Formation and stability of ω-3 oil emulsion-based delivery systems using plant proteins as emulsifiers: Lentil, pea, and faba bean proteins. *Food Biophysics*, 12(2), 186-197. http://dx.doi.org/10.1007/s11483-017-9475-6

Haas, R., Schnepps, A., Pichler, A., & Meixner, O. (2019). Cow milk versus plant-based milk substitutes: A comparison of product image and motivational structure of consumption. *Sustainability*, 11(18), 5046. https://doi.org/10.3390/su11185046

Hayat, I., Ahmad, A., Masud, T., Ahmed, A., & Bashir, S. (2014). Nutritional and health perspectives of beans (*Phaseous vulgaris* L.): an overview. *Critical Reviews in Food Science and Nutrition*, 54 (5), 580-92. http://dx.doi.org/10.1080/10408398.2011.596639

Heaney, R. P., & Rafferty, K. (2006). The settling problem in calcium-fortified soybean drinks. *Journal of the American Dietetic Association*, 106(11), 1753-1754. http://dx.doi.org/10.1016/j.jada.2006.08.008

Hsiao, Y. H., Ho, C. T., & Pan, M. H. (2020). Bioavailability and health benefits of major isoflavone aglycones and their metabolites. *Journal of Functional Foods*, 74, 104164. https://doi.org/10.1016/j.jff.2020.104164

Hu, J., Zheng, Y. L., Hyde, W., Endrich, S., Murphy, P. A. (2004). Human fecal metabolism of soyasaponin I. *Journal of Agricultural and Food Chemistry*, 52(9), 2689-2696. http://dx.doi.org/10.1021/jf035290s

Huang, H., Liang, H., & Kwok, K. C. (2006). Effect of thermal processing on genistein, daidzein and glycitein content in soymilk. *Journal of the Science of Food and Agriculture*, 86(7), 1110-1114. https://doi.org/10.1002/jsfa.2465

Institute of Medicine (US) Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. (1997). Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride; Institute of Medicine (US) Standing Committee on the Scientific Evaluation of Dietary Reference Intakes: Washington, DC, USA. http://dx.doi.org/10.17226/5776

Iorio, M. C., Bevilacqua, A., Corbo, M. R., Campaniello, D., Sinigaglia, M., & Altieri, C. (2019). A case study on the use of ultrasound for the inhibition of Escherichia coli O157: H7 and Listeria monocytogenes in almond milk. *Ultrasonics Sonochemistry*, 52, 477-83. http://dx.doi.org/10.1016/j.ultsonch.2018.12.026

Iswarin, S. J., & Permadi, B. (2012). Coconut milk's fat breaking by means of ultrasound. *International Journal of Basic and Applied Science*, 12, 1-5. Corpus ID: 15923949

Jeske, S., Zannini, E., & Arendt, E. K. (2017). Evaluation of physicochemical and glycaemic properties of commercial plant-based milk substitutes. *Plant Foods for Human Nutrition*, 72(1), 26-33. http://dx.doi.org/10.1007/s11130-016-0583-0

Jain, P., Yadav, D. N., Rajput, H., & Bhatt, D. K. (2013). Effect of pressure blanching on sensory and proximate composition of peanut milk. *Journal of food science and technology*, 50(3), 605-608. http://dx.doi.org/10.1007/s13197-011-0373-5

Jeske, S., Zannini, E., & Arendt, E. K. (2018). Past, present and future: The strength of plant-based dairy substitutes based on gluten-free raw materials. *Food Research International*, 110, 42-51. https://doi.org/10.1016/j.foodres.2017.03.045

Kamo, S., Suzuki, S., & Sato, T. (2014). The content of soyasaponin and soyasapogenol in soy foods and their estimated intake in the Japanese. *Food Science & Nutrition*, 2(3), 289-297. http://dx.doi.org/10.1002/fsn3.107

Kaur, N., Chugh, V., & Gupta, A. K. (2014). Essential fatty acids as functional components of foods-a review. *Journal of Food Science and Technology*, 51(10), 2289-2303. http://dx.doi.org/10.1007/s13197-012-0677-0

Khazai, N., Judd, S. E., & Tangpricha, V. (2008). Calcium and vitamin D: skeletal and extraskeletal health. *Current rheumatology reports*, 10(2), 110-117. http://dx.doi.org/10.1007/s11926-008-0020-y

Khodke, S. U., Shinde, K. S., & Yenge, G. B. (2014). A study on the storage of sterilized soymilk. *International Journal of Farm Sciences*, 4(4), 166-179.

Knorr, D., Froehling, A., Jaeger, H., Reineke, K., Schlueter, O., & Schoessler, K. (2011). Emerging technologies in food processing. *Annual Review of Food Science and Technology*, 2,203-235. https://doi.org/10.1146/annurev.food.102308.124129

Kohli, D., Kumar, S., Upadhyay, S., & Mishra, R. (2017). Preservation and processing of soymilk: A review. *International Journal of Food Science and Nutrition*, 2(6), 66-70. http://www.foodsciencejournal.com/archives/2017/vol2/issue6/2-6-26

Krajcovicova-Kudlackova, M., Babinska, K., & Valachovicova, M. (2005). Health benefits and risks of plant proteins. *Bratislava Medical Journal*, 106(6/7), 231. PMID: 16201743

Kris-Etherton, P. M., Pearson, T. A., Wan, Y., Hargrove, R. L., Moriarty, K., Fishell, V., & Etherton, T. D. (1999). High-monounsaturated fatty acid diets lower both plasma cholesterol and triacylglycerol concentrations. *The American Journal of Clinical Nutrition*, 70(6), 1009-1015. http://dx.doi.org/10.1093/ajcn/70.6.1009

Kritchevsky, D., & Chen, S. C. (2005). Phytosterols-health benefits and potential concerns: a review. *Nutrition Research*, 25(5), 413-428. http://dx.doi.org/10.1016/j.nutres.2005.02.003

Kruger, M. C., Gallaher. B. W., & Schollum, L. M. (2003). Bioavailability of calcium is equivalent from milk fortified with either calcium carbonate or milk calcium in growing male rats. *Nutrition research*, 23(9), 1229-1237. https://agris.fao.org/agris-search/search.do?recordID=US201600076656

Kwok, K. C., Liang, H. H., & Niranjan, K. (2002). Optimizing conditions for thermal processes of soy milk. *Journal of Agricultural and Food Chemistry*, 50(17), 4834-4838. http://dx.doi.org/10.1021/jf020182b

Lai, L. R., Hsieh, S. C., Huang, H. Y., & Chou, C. C. (2013). Effect of lactic fermentation on the total phenolic, saponin and phytic acid contents as well as anti-colon cancer cell proliferation activity of soymilk. *Journal of Bioscience and Bioengineering*, 115(5), 552-556. http://dx.doi.org/10.1016/j.jbiosc.2012.11.022

Lee, D. U., Heinz, V., & Knorr, D. (2003). Effects of combination treatments of nisin and high-intensity ultrasound with high pressure on the microbial inactivation in liquid whole egg. *Innovative Food Science & Emerging Technologies*, 4(4), 387-393. http://dx.doi.org/10.1016/S1466-8564(03)00039-0

Lee, S. W., & Rhee, C. (2003). Processing suitability of a rice and pine nut (Pinus koraiensis) beverage. *Food Hydrocolloids*, 17(3), 379-385. http://dx.doi.org/10.1016/S0268-005X(02)00121-2

Li, Q., Zhao, Y., Zhu, D., Pang, X., Liu, Y., Frew, R., & Chen, G. (2017). Lipidomics profiling of goat milk, soymilk and bovine milk by UPLC-Q-Exactive Orbitrap Mass Spectrometry. *Food Chemistry*, 224, 302-309 https://doi.org/10.1016/j.foodchem.2016.12.083

Li, Y. Q., Tian, W. L., Mo, H. Z., Zhang, Y. L., & Zhao, X. Z. (2013). Effects of pulsed electric field processing on quality characteristics and microbial inactivation of soymilk. *Food and Bioprocess Technology*, 6, 1907-1916. http://dx.doi.org/10.1007/s11947-012-0868-8

Lifschitz, C., & Szajewska, H. (2015). Cow's milk allergy: evidence-based diagnosis and management for the practitioner. *European Journal of Pediatrics*, 174(2), 141-150. http://dx.doi.org/10.1007/s00431-014-2422-3

Lindahl, L., Ahlden, I., Oste ,R., & Sjoholm, I, inventors, Lindahl, Lennart, Ahlden, Inger, Oeste, Rickard, Sjoeholm, Assignee. (1997). Homogeneous and stable cereal suspension and a method of making the same. United States patent US 5,686,123.

Lins, M. D., Horowitz, M. R., Silva, G. A. (2010). Oral food challenge test to confirm the diagnosis of cow's milk allergy. *Jornal de pediatria*, 86, 285-289. http://dx.doi.org/10.2223/JPED.2011

Liu, C., Cheng, F., & Yang, X. (2017). Inactivation of soybean trypsin inhibitor by epigallocatechin gallate: Stopped-flow/fluorescence, thermodynamics, and docking studies. *Journal of Agricultural and Food Chemistry*, 65(4), 921-929. http://dx.doi.org/10.1021/acs.jafc.6b04789

Liu, C., Luo, L., Wu, Y. (2019). Inactivation of soybean Bowman-Birk inhibitor by stevioside: Interaction studies and application to soymilk. *Journal of Agricultural and Food Chemistry*, 67(8), 2255-2264. https://doi.org/10.1021/acs.jafc.8b05609

Mäkinen, O. E., Wanhalinna, V., Zannini, E., & Arendt, E. K. (2016). Foods for special dietary needs: Non-dairy plant-based milk substitutes and fermented dairy-type products. *Critical Reviews in Food Science and Nutrition*, 56(3), 339-349. http://dx.doi.org/10.1080/10408398.2012.761950

Maleki, N., Khodaiyan, F., & Mousavi, S. M. (2015). Antioxidant activity of fermented Hazelnut milk. *Food Science and Biotechnology*, 24(1), 107-115. https://doi.org/10.1007/s10068-015-0016-0

Manassero, C. A., Anon, M. C., & Speroni, F. (2020). Development of a high protein beverage based on amaranth. *Plant Foods For Human Nutrition*, 75(4), 599-607. http://dx.doi.org/10.1007/s11130-020-00853-9

Manzoor, M. F., Manzoor, A., Siddique, R., & Ahmad, N. (2017). Nutritional and sensory properties of cashew seed (Anacardium occidentale) milk. *Modern Concepts & Developments in Agronomy*, 1(1), 1-4. http://dx.doi.org/10.31031/MCDA.2017.01.000501

Maria, M. F., & Victoria, A. T. (2018). Influence of processing treatments on quality of vegetable milk from almond (Terminalia catappa) kernels. *ACTA Scientific Nutritional Health*, 2(6), 37-42. https://actascientific.com/ASNH/pdf/ASNH-02-0090.pdf

Mathai, J. K., Liu, Y., & Stein, H. H. (2017). Values for digestible indispensable amino acid scores (DIAAS) for some dairy and plant proteins may better describe protein quality than values calculated using the concept for protein digestibility-corrected amino acid scores (PDCAAS). *British Journal of Nutrition*, 117(4),490-499. http://dx.doi.org/10.1017/S0007114517000125

Mazumder, M. A. R., & Begum, A. A. (2016). Soy milk as source of nutrient for malnourished population of developing country: A review. *International Journal of Advanced Scientific and Technical Research*, 6, 192-203.

McClements, D. J., & Gumus, C. E. (2016). Natural emulsifiers—Biosurfactants, phospholipids, biopolymers, and colloidal particles: Molecular and physicochemical basis of functional performance. *Advances in Colloid and interface Science*, 234, 3-26. http://dx.doi.org/10.1016/j.cis.2016.03.002

McClements, D. J., Newman, E., & McClements. I. F. (2019). Plant-based milks: A review of the science underpinning their design, fabrication, and performance. *Comprehensive Reviews in Food Science and Food Safety*, 18(6), 2047-2067. https://doi.org/10.1111/1541-4337.12505

Milbury, P. E., Chen, C.Y., Dolnikowski, G. G., Blumberg, J. B. (2006). Determination of flavonoids and phenolics and their distribution in almonds. *Journal of Agricultural and Food Chemistry*, 54(14), 5027-5033. http://dx.doi.org/10.1021/jf0603937

Mitchell, C. R., Mitchell, P. R., & Nissenbaum, R. (1988). Nutritional Rice Milk Production. U.S. Patent 4744992. https://patents.google.com/patent/US4744992A/en

Mitchell, T., Kumar, P., Reddy, T., Wood, K. D., Knight, J., Assimos, D. G., & Holmes, R. (2019). Dietary oxalate and kidney stone formation. American *Journal of Physiology-Renal Physiology*, 316(3), 409-413. http://dx.doi.org/10.1152/ajprenal.00373.2018

Morales-de, La., Peña, M., Salvia-Trujillo, L., Rojas-Graü, M. A., & Martín-Belloso, O. (2010). Impact of high intensity pulsed electric field on antioxidant properties and quality parameters of a fruit juice-soymilk beverage in chilled storage. *LWT-Food Science and Technology*, 43(6), 872-881. https://doi.org/10.1016/j.lwt.2010.01.015

Moretto, L., Tonolo, F., Folda, A., Scalcon, V., Bindoli, A., Bellamio, M., Feller, E., & Rigobello, M. P. (2021). Comparative analysis of the antioxidant capacity and lipid and protein oxidation of soy and oats beverages. *Food Production, Processing and Nutrition*, 3(1), 1-10. http://dx.doi.org/10.1186/s43014-020-00046-6

Mousan, G., & Kamat, D. (2016). Cow's milk protein allergy. *Clinical paediatrics*, 55(11), 1054-1063. https://doi.org/10.1177/0009922816664512

Munekata, P. E., Domínguez, R., Budaraju, S., Rosello-Soto, E., Barba, F. J., Mallikarjunan, K., Roohinejad, S., & Lorenzo, J. M. (2020). Effect of innovative food processing technologies on the physicochemical and nutritional properties and quality of non-dairy plant-based beverages. Foods, 9(3), 288. http://dx.doi.org/10.3390/foods9030288

National Institutes of Health. Calcium - Fact sheet for health professionals. Available from: https://ods.od.nih.gov/factsheets/Calcium-HealthProfessional. Accessed December 13, 2021.

Nair, U. K. A., Hema, V., Sinija, V. R., & Hariharan, S. (2019). Millet milk: A comparative study on the changes in nutritional quality of dairy and nondairy milks during processing and malting. *Journal of Food Process Engineering*, 43 (7). http://dx.doi.org/10.1111/jfpe.13324

Namiki, M. (2007). Nutraceutical functions of sesame: A review. *Critical Review in Food Science Nutrition*, 47, 651-673. http://dx.doi.org/10.1080/10408390600919114

Naziri, E., Koupantsis, T., Mantzouridou, F. T., Paraskevopoulou, A., Tsimidou, M. Z., & Kiosseoglou, V. (2017). Influence of thermal treatment on the stability of vegetable "milk" obtained by ultrafiltration of aqueous oil body extracts from various sources. *European Journal of Lipid Science and Technology*, 119(7), 1-13. https://doi.org/10.1002/ejlt.201600362

Ojha, K. S., Keenan, D. F., Bright, A., Kerry, J. P., & Tiwari, B. K. (2015). Ultrasound assisted diffusion of sodium salt replacer and effect on physicochemical properties of pork meat. *International Journal of Food Science &Technology*, 51(1),37-45. http://dx.doi.org/10.1111/IJFS.13001

Okura, T., Ibe, M., Umegaki, K., Shinozuka, K., & Yamada, S. 2010. Effects of dietary ingredients on function and expression of P-glycoprotein in human intestinal epithelial cells. *Biological and Pharmaceutical Bulletin*. 33(2), 255-259. https://doi.org/10.1248/bpb.33.255

Okyere, A. A., & Odamtten, G. T. (2014). Physicochemical, functional and sensory attributes of milk prepared from irradiated tiger nut (Cyperus esculentus L.). *Journal of Radiation Research and Applied Sciences*, 7(4), 583-588. https://inis.iaea.org/search/search.aspx?orig_q=RN:50005564

Omoni, A. O., & Aluko, R. E. (2005). Soybean foods and their benefits: Potential mechanisms of action. *Nutrition Reviews*, 63, 272-283. http://dx.doi.org/10.1111/j.1753-4887.2005.tb00141.x

Onning, G., Wallmark, A., Persson, M., Akesson, B., Elmståhl, S., Oste, R. (1999). Consumption of oat milk for 5 weeks lowers serum cholesterol and LDL cholesterol in free-living men with moderate hypercholesterolemia. *Annals of Nutrition and Metabolism*, 43(5), 301-309. http://dx.doi.org/10.1159/000012798

Pardeshi, I. L., Murumkar, R. P., & Tayade, P. T. (2014). Optimization of process for spray drying of soymilk and sprouted soybean milk. *Journal of Grain Processing and Storage*, 1(1), 13-20. http://www.jakraya.com/journal/pdf/1-jgpsArticle_3.pdf

Pathomrungsiyounggul, P., Lewis, M. J., & Grandison, A. S. (2010). Effects of calcium-chelating agents and pasteurisation on certain properties of calcium-fortified soy milk. *Food Chemistry*, 118(3), 808-814. http://dx.doi.org/10.1016/j.foodchem.2009.05.067

Patil, U., & Benjakul, S. (2018). Coconut milk and coconut oil: Their manufacture associated with protein functionality. *Journal of Food Science*, 83 (8), 2019-27. http://dx.doi.org/10.1111/1750-3841.14223

Paul, A. A., Kumar, S., Kumar, V, & Sharma, R. (2020). Milk Analog: Plant based alternatives to conventional milk, production, potential and health concerns. *Critical Reviews in Food Science and Nutrition*, 60(18), 3005-3023. http://dx.doi.org/10.1080/10408398.2019.1674243

Pereira, P. C. (2014). Milk nutritional composition and its role in human health. *Nutrition*, 30(6), 619-627. http://dx.doi.org/10.1016/j.nut.2013.10.011

Pineli, L. De. L. De. O., Botelho, R. B., Zandonadi, R. P., Solorzano, J. L., de Oliveira, G. T., Reis, C. E. G., & Teixeira, D. D. S. (2015). Low glycemic index and increased protein content in a novel quinoa milk. *LWT - Food Science and Technology*, 63(2),1261-1267. http://dx.doi.org/10.1016/j.lwt.2015.03.094

Piyasena, P., Mohareb, E., & McKellar, R. C. (2003). Inactivation of microbes using ultrasound: a review. *International Journal of Food Microbiology*, 7(3), 207-216. http://dx.doi.org/10.1016/S0168-1605(03)00075-8

Poliseli-Scopel, F. H., Hernández-Herrero, M., Guamis, B., & Ferragut, V. (2012). Comparison of ultra high pressure homogenization and conventional thermal treatments on the microbiological, physical and chemical quality of soymilk. *LWT-Food Science and Technology*, 46(1), 42-8. https://doi.org/10.1016/j.lwt.2011.11.004

Popova, A., & Mihaylova, D. (2019). Antinutrients in plant-based foods: A review. *The Open Biotechnology Journal*, 13(1), 68-76. http://dx.doi.org/10.2174/1874070701913010068

Raso, J., & Barbosa-Cánovas, G.V. (2003). Nonthermal preservation of foods using combined processing techniques. *Critical Reviews in Food Science and Nutrition*, 43(3), 265-285. https://doi.org/10.1080/10408690390826527

Rekha, C. R., & Vijayalakshmi, G. (2010). Bioconversion of isoflavone glycosides to aglycones, mineral bioavailability and vitamin B complex in fermented soymilk by probiotic bacteria and yeast. *Journal of Applied Microbiology*, 109(4), 1198-1208. http://dx.doi.org/10.1111/j.1365-2672.2010.04745.x

Reyes-Jurado, F., Soto-Reyes, N., Dávila-Rodríguez, M., Lorenzo- Leal, A.C., Jiménez-Munguía, M. T., Mani-López, E., & López-Malo, A. (2021). Plant-Based

Milk Alternatives: Types, Processes, Benefits, and Characteristics. *Food Reviews International*, 1-32. http://dx.doi.org/10.1080/87559129.2021.1952421

Richardson, D. P. (1990). Food fortification. *Proceedings of the Nutrition Society*, 49(1), 39-50. http://dx.doi.org/10.1079/PNS19900007

Rodríguez, U. S., Matallana-González, M. C., Sánchez-Mata, M. C. (2018). Lactose malabsorption and intolerance: a review. *Food & function*, 9(8), 4056-4068. http://dx.doi.org/10.1039/c8fo00555a

Rosenthal, A., Deliza, R., Cabral, L. M. C., & Cabral, L. C. (2003). Effect of enzymatic treatment and filtration on sensory characteristics and physical stability of soymilk. *Food Control*, 14(3), 187-192. https://doi.org/10.1016/S0956-7135(02)00087-7

Ruxton, C. H., Reed, S. C., Simpson, M. J., & Millington, K. J. (2004). The health benefits of omega-3 polyunsaturated fatty acids: a review of the evidence. *Journal of Human Nutrition and Dietetics*, 17(5), 449-459. https://doi.org/10.1111/j.1365-277X.2004.00552.x

Sabliov, C. M., Boldor, D., Coronel, P., & Sanders, T. H. (2008). Continuous microwave processing of peanut beverages. *Journal of Food Processing and Preservation*, 32(6), 935-945. https://doi.org/10.1111/j.1745-4549.2008.00223.x

Sala, F. J., Burgos, J., Condon, S., Lopez, P., & Raso, J. (1995). Effect of heat and ultrasound on microorganisms and enzymes. pp. 176-204. In: *New Methods of Food Preservation*. Gould GW (ed.). Springer, Boston, MA.

Salehi, B., Quispe, C., Sharifi-Rad, J., Cruz-Martins, N., Nigam, M., Mishra, A. P., Konovalov, D. A., Orobinskaya, V., Abu-Reidah, I. M., Zam, W., Sharopov, F., Venneri, T., Capasso, R., Kukula-Koch, W., Wawruszak, A., Koch, W. (2021). Phytosterols: From preclinical evidence to potential clinical applications. *Frontiers in Pharmacology*, 11, 1819. https://doi.org/10.3389/fphar.2020.599959

Samtiya, M., Aluko, R. E., & Dhewa, T. (2020). Plant food anti-nutritional factors and their reduction strategies: An overview. *Food Production, Processing and Nutrition*, 2(1), 1-14. http://dx.doi.org/10.1186/s43014-020-0020-5

Sanful, R. E. (2009). Production and sensory evaluation of tigernut beverages. *Pakistan Journal of Nutrition*, 8, 688-690. http://dx.doi.org/10.3923/pjn.2009.688.690

Sangami, R., & Radhai, Sri. S. (2018). Extraction and standardization of indigenous oat milk. *International journal of current advanced research*, 7(8), 14912-14915.

Sango, D. M., Abela, D., McElhatton, A., & Valdramidis, V. P. (2014). Assisted ultrasound applications for the production of safe foods. *Journal of Applied Microbiology*, 116(5), 1067-1083. http://dx.doi.org/10.1111/jam.12468

Sanni, A. I., Onilude, A. A., & Adeleke, E. O. (1999). Preparation and characteristics of lactic acid fermented cowpea milk. *Zeitschrift für Lebensmitteluntersuchung und-Forschung A*, 208(3), 225-229.

Schaafsma, G. (2000) The Protein Digestibility-Corrected Amino Acid Score. *The Journal of Nutrition*, 130(7), 1865-1867. https://dx.doi.org/10.1093/jn/130.7.1865S

Scholz-Ahrens, K. E., Ahrens, F., & Barth, C. A. (2020). Nutritional and health attributes of milk and milk imitations. *European Journal of Nutrition*, 59(1), 19-34. http://dx.doi.org/10.1007/s00394-019-01936-3

Seow, C. C., & Gwee, C. N. (1997). Coconut milk: chemistry and technology. *International Journal of Food Science & Technology*, 32(3), 189-201. https://doi.org/10.1046/j.1365-2621.1997.00400.x

Setchell, K. D., Brown, N. M., Zimmer-Nechemias, L., Brashear, W. T., Wolfe, B. E., Kirschner, A. S., & Heubi, J. E. (2002). Evidence for lack of absorption of soy isoflavone glycosides in humans, supporting the crucial role of intestinal metabolism for bioavailability. *The American Journal of Clinical Nutrition*, 76(2), 447-453. http://dx.doi.org/10.1093/ajcn/76.2.447

Sethi, S., Tyagi, S. K., & Anurag, R. K. (2016). Plant-based milk alternatives an emerging segment of functional beverages: a review. *Journal of Food Science and Technology*, 53(9), 3408-3423. http://dx.doi.org/10.1007/s13197-016-2328-3

Shahidi, F., Liyana-Pathirana, C. M., & Wall, D. S. (2006). Antioxidant activity of white and black sesame seeds and their hull fractions. *Food Chemistry*, 99(3), 478-83. http://dx.doi.org/10.1016/j.foodchem.2005.08.009

Shakerardekani, A., Karim, R., & Vaseli, N. (2013). The effect of processing variables on the quality and acceptability of pistachio milk. *Journal of Food Processing and Preservation*, 37 (5), 541-5. https://doi.org/10.1111/j.1745-4549.2012.00676.x

Sharma, V., Singh, R., & Toledo, R. T. (2009). Microbial inactivation kinetics in soymilk during continuous flow high pressure throttling. *Journal of Food Science*, 74(6), 268-275. https://doi.org/10.1111/j.1750-3841.2009.01201.x

Shen, P., Walker, G. D., Yuan, Y., Reynolds, C., Stanton, D. P., Fernando, J. R., & Reynolds, E. C. (2019). Effects of soy and bovine milk beverages on enamel mineral content in a randomized, double-blind in situ clinical study. *Journal of Dentistry*, 88, 103160. http://dx.doi.org/10.1016/j.jdent.2019.06.007

Sidhu, J. S., & Singh, R. K. (2016). Ultra high pressure homogenization of soy milk: Effect on quality attributes during storage beverages. *Beverages*, 2 (2), 15. https://doi.org/10.3390/beverages2020015

Silva, A. R., Silva, M. M., & Ribeiro, B. D. (2020). Health issues and technological aspects of plant-based alternative milk. *Food Research International*, 131, 108972. http://dx.doi.org/10.1016/j.foodres.2019.108972

Sivanandan, L., Toledo, R. T., & Singh, R. (2008). Effect of continuous flow high-pressure throttling on rheological and ultrastructural properties of soymilk. *Journal of Food Science*, 73(6), 288-296. http://dx.doi.org/10.1111/j.1750-3841.2008.00803.x

Sousa, A., & Kopf, K. A. (2017). Nutritional Implications of an Increasing Consumption of Non-Dairy Plant-Based Beverages Instead of Cow's Milk in Switzerland. *Advances in Dairy Research*, 5(04), 1-7. http://dx.doi.org/10.4172/2329-888X.1000197

Srinivasan, V. S. (2001). Bioavailability of nutrients: a practical approach to In Vitro demonstration of the availability of nutrients in multivitamin-mineral combination products. *Journal of Nutrition*, 131(4), 1349S-50S. http://dx.doi.org/10.1093/jn/131.4.1349S

Stoica, M., Bahrim, G., & Cârâc, G. (2011). Factors that Influence the Electric Field Effects on Fungal Cells. pp. 291-302. In: *Science against microbial pathogens: communicating current research and technological advances*, Méndez-Vilas A (ed.). Formatex Research Center, Badajoz. Corpus ID: 11651452

Syed, S. J., Gadhe, K. S., & Shaikh, R. P. (2020). Studies on quality evaluation of OAT milk. *Journal of Pharmacognosy and Phytochemistry*, 9(1), 2275-2277.

Tangsuphoom, N., & Coupland, J. N. (2005). Effect of heating and homogenization on the stability of coconut milk emulsions. *Journal of Food Science*, 70(8), e466-70. http://dx.doi.org/10.1111/j.1365-2621.2005.tb11516.x

Teucher, B., Olivares, M., & Cori, H. (2004). Enhancers of iron absorption: ascorbic acid and other organic acids. *International Journal for Vitamin and Nutrition Research*, 74(46), 403-19. http://dx.doi.org/10.1024/0300-9831.74.6.403

Theodoropoulos, V. C. T., Turatti, M. A., Greiner, R., Macedo, G. A., & Pallone, J. A. L. (2018). Effect of enzymatic treatment on phytate content and mineral bioacessability in soy drink. *Food Research International*, 108, 68-73. https://doi.org/10.1016/j.foodres.2018.03.018

Tiwari, B. K., Muthukumarappan, K., O'donnell, C. P., Cullen, P. J. (2009). Inactivation kinetics of pectin methylesterase and cloud retention in sonicated orange juice. *Innovative Food Science & Emerging Technologie,s* 10(2), 166-171. https://pubag.nal.usda.gov/catalog/749297

Tomaino, A., Martorana, M., Arcoraci, T., Monteleone, D., Giovinazzo, C., & Saija, A. (2010). Antioxidant activity and phenolic profile of pistachio (Pistacia vera L., variety Bronte) seeds and skins. *Biochimie*, 92(9), 1115-1122. http://dx.doi.org/10.1016/j.biochi.2010.03.027

Ukwuru, M. U., & Ogbodo, A. C. (2011). Effect of processing treatment on the quality of tigernut milk. *Pakistan Journal of Nutrition*, 10(1), 95-100. http://dx.doi.org/10.3923/PJN.2011.95.100

Vagadia, B. H., Vanga, S. K., & Raghavan, V. (2017). Inactivation methods of soybean trypsin inhibitor-A review. *Trends in Food Science & Technology*, 64, 115-125. http://dx.doi.org/10.1016/j.tifs.2017.02.003

Vagadia, B. H., Vanga, S. K., Singh, A., Gariepy, Y., & Raghavan, V. (2018). Comparison of conventional and microwave treatment on soymilk for inactivation of trypsin inhibitors and in vitro protein digestibility. *Foods*, 7(1), 6. https://doi.org/10.3390/foods7010006

Vahanvaty, U. S. (2009). Hemp seed and hemp milk: the new super foods? *ICAN: Infant, Child, & Adolescent Nutrition*, 1, 232-234. http://dx.doi.org/10.1177/1941406409342121

Valencia-Flores, D. C., Hernández-Herrero, M., Guamis, B., & Ferragut, V. (2013). Comparing the effects of ultra-high-pressure homogenization and conventional thermal treatments on the microbiological, physical, and chemical quality of almond beverages. *Journal of Food Science* 78(2), E199-205 http://dx.doi.org/10.1111/1750-3841.12029

Van Impe, J., Smet, C., Tiwari, B., Greiner, R., Ojha, S., Stulić, V., Režek Jambrak, A. (2018). State of the art of nonthermal and thermal processing for inactivation of micro-organisms. *Journal of Applied Microbiology*, 125(1), 16-35. http://dx.doi.org/10.1111/jam.13751

Vanga, S. K., & Raghavan, V. (2018). How well do plant based alternatives fare nutritionally compared to cow's milk? *Journal of Food Science and Technology*, 55(1), 10-20. http://dx.doi.org/10.1007/s13197-017-2915-y

Vanga, S. K., Wang, J., & Raghavan, V. (2020). Effect of ultrasound and microwave processing on the structure, in-vitro digestibility and trypsin inhibitor activity of soymilk proteins. *LWT-Food Science and Technology*, 131, 109708. https://doi.org/10.1016/j.lwt.2020.109708

Varghese, T., & Pare, A. (2019). Effect of microwave assisted extraction on yield and protein characteristics of soymilk. *Journal of Food Engineering*, 262, 92-99. http://dx.doi.org/10.1016/J.JFOODENG.2019.05.020

Vasavada, P. C. (1990). Microwave processing for the dairy industry. *Food Australia*, 42(12), 562-564.

Wang, Q., Jiang, J., & Xiong, Y. L. (2018). High pressure homogenization combined with pH shift treatment: A process to produce physically and oxidatively stable hemp milk. *Food Research International*, 106, 487-494. http://dx.doi.org/10.1016/j.foodres.2018.01.021

Whitehead, A., Beck, E. J., Tosh, S., & Wolever, T. M. (2014). Cholesterol-lowering effects of oat β-glucan: a meta-analysis of randomized controlled trials. *The American Journal of Clinical Nutrition*, 100(6), 1413-1421. http://dx.doi.org/10.3945/ajcn.114.086108

Yadav, P. B., Edukondalu, L., Patel, S., & Rao, D. B. (2018). Proximate Composition of Peanut Milk Prepared by Different Methods. *International Journal of Current Microbiology and Applied Sciences*, 7(10), 2388-2391. http://dx.doi.org/10.20546/IJCMAS.2018.710.276

Yuan, S., Chang, S. K., Liu, Z., & Xu, B. (2008). Elimination of trypsin inhibitor activity and beany flavor in soy milk by consecutive blanching and ultrahigh-temperature (UHT) processing. *Journal of Agricultural and Food Chemistry* 56(17), 7957-7963. https://doi.org/10.1021/jf801039

Zaaboul F, Raza H, Cao C and Yuanfa, L. (2019). The impact of roasting, high pressure homogenization and sterilization on peanut milk and its oil bodies. *Food Chemistry*, 280, 270-277. http://dx.doi.org/10.1016/j.foodchem.2018.12.047

Zhao, Y., Martin, B. R., & Weaver, C. M. (2005). Calcium bioavailability of calcium carbonate fortified soymilk is equivalent to cow's milk in young women. *The Journal of Nutrition*, 135(10), 2379-2382. http://dx.doi.org/10.1093/jn/135.10.2379

Zimmermann, U. (1986). Electrical breakdown, electropermeabilization and electrofusion. pp. 175-256. In: *Reviews of Physiology, Biochemistry and Pharmacology*. Springer, Berlin, Heidelberg. PMID: 3541139